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Plankton of the Bermuda Oceanographic Expeditions. VIII. Medusae Taken During the Years 1929 and 1930[1].

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(Text-figs. 1-23).

[This is one of a number of papers dealing with the planktonic contents of nets drawn at various levels off the coast of Bermuda on the Bermuda Oceanographic Expeditions of the New York Zoological Society under the direction of Dr. William Beebe. Full details of the nets, locality, etc., will be found in *Zoologica*, Volume XIII, Numbers 1, 2 and 3, and Volume XXI, Numbers 3 and 4.]

CONTENTS.

INTRODUCTION.

The medusae recorded in the following pages were taken by Dr. William Beebe within a roughly circular area, some eight miles in diameter, centering about 9 miles about south-southeast from the eastern end of the Bermuda archipelago. Within the area of study, the depth ranges from 1,357 to somewhat less than 1,500 fathoms.

Horizontal towing with open nets was carried out in each year at frequent intervals from April through September, at various levels from the surface down to 2,195-0 meters, the total number of tows being 528 for 1929, 488 for 1930. An account of methods of collection, with list of tows, has been given by Beebe (1931). In this list, the depths stated are those at which the horizontal parts of the tows were made, determined—at least in some cases—by a recording pressure-gauge or "Bathygraph" (Beebe, 1931, p. 13, Fig. 6). But one must remember that as the nets used were of the ordinary open type, which fish nearly as effectively while being lowered as while being towed horizontally, and as effectively while being hauled up again, there is no way of determining from what depth any particular specimen may have come. The depths of the hauls, given under the several species in the following pages, are therefore stated accordingly. However, so many hauls were made on each towing day, and at so many different levels, that differential results show fairly well the upper limits of occurrence; also the chief levels of abundance for the more common species. But none of the species was taken in numbers large enough to allow calculation of the probable degree to which the catches were contaminated by specimens picked up during the vertical parts of the tows (for further discussion of this subject see Bigelow and Sears, 1937, p. 69).

The collection contains no new species. But it adds to morphological knowledge of several. And it is especially interesting from the distributional standpoint, being the only intensive and long-continued campaign of deep towing that has yet been made at one place in the open ocean. With so many hauls, made at such close intervals, it is unlikely that any medusa was missed that was at all common, or that occurred other than sporadically. It is therefore safe to assume that the catches listed below give a representative picture of all the species of medusae that occurred with any regularity between the surface and the bottom of the sea, at the chosen station, during the summers of 1929 and 1930, except *Cyanea*, which as Dr. Beebe informs me, was occasionally seen at the surface.

ANTHOMEDUSAE.

CLADONEMIDAE.

Zancleopsis.

This genus was proposed by Hartlaub (1907, p. 116) for a bitentaculate medusa from the Tortugas, described by Mayer (1900) as *Gemmaria dichotoma,* but which differs from typical *Gemmaria* (the latter is probably a synonym of *Zanclea*) in the fact that its tentacles are branched, with the branches as well as the main trunk terminating in swollen bulbs; structures very different from the stalked nematocyst knobs with which the tentacles of *Gemmaria* (or *Zanclea*) are armed. *Zancleopsis* also possesses ocelli, which are lacking in *Gemmaria.* And the new genus was accepted by Mayer (1910) in his subsequent monograph.

Zancleopsis was not reported again until 1928 when Kramp (1928, p. 40) described a second species—*tentaculata*—from a single specimen from the Pacific. The Bermuda series now yields a third record of the genus.

Mayer's specimens from the Tortugas had only two developed tentacles. But it appears that they were juveniles, for while he stated that the gonads are developed on the inter-radial sides of the manubrium, his illustrations give no indication that the sex tissue had actually appeared, which accords with the small size of the specimens (3 mm. high), contrasted with the Bermudian example (20 mm. high). Therefore, it is entirely possible that the bulbs alternating with the formed tentacles of Mayer's specimens would later have developed filaments, thus raising the tentacle number to four. And this is made the more likely by the fact that Kramp's Pacific specimen (4.5 mm. high) showed just this state, i. e., one pair of large branched tentacles and one pair of much smaller simple tentacles. It also showed a more advanced stage in the sexual development, with the gonads forming "a number of vertical folds, four on each of the inter radial sides of the stomach" (Kramp, 1928, p. 41). The Bermuda example illustrates a stage still more advanced, the sex folds being more numerous (p. 104), the secondary tentacles about as long as the primary, though still continuing simple, and the size much greater. In short, it seems altogether probable that we have to do here with the final stage in growth of Mayer's juvenile *Z. dichotoma,* a conclusion favored by the fact that there is no faunistic discontinuity, so far as medusae are concerned, between Bermuda and southern Florida.

But it appears that the Pacific *Z. tentaculata* is distinct, for not only does it have large gonads at a much smaller size, but the tentacular spurs, bearing the ocelli, are not so highly developed, and the edges of its radial canals are pictured by Kramp as smooth, whereas they are jagged in the Bermuda specimen.

Zancleopsis dichotoma Mayer.

Gemmaria dichotoma, Mayer, 1900, p. 35, Pl. 17, Fig. 40.
Zancleopsis dichotoma, Hartlaub, 1907, p. 115; Kramp, 1928, p. 42.

Material: Net No. 922, 1,097-0 meters, September 20, 1930, 1 specimen, 20 mm. high by 14 mm. broad, in good condition.

As the adult has not been seen previously, an account of the significant features follows:

The bell is high domed, moderately thick walled, especially apically (Text-fig. 1), resembling Kramp's (1928, Fig. 14) picture of the Pacific *tentaculata* in general form, except that the apex is rounded instead of pointed. And this minor difference may be merely the result of the preservative. The exumbrella is smooth as Hartlaub has also noted, without any
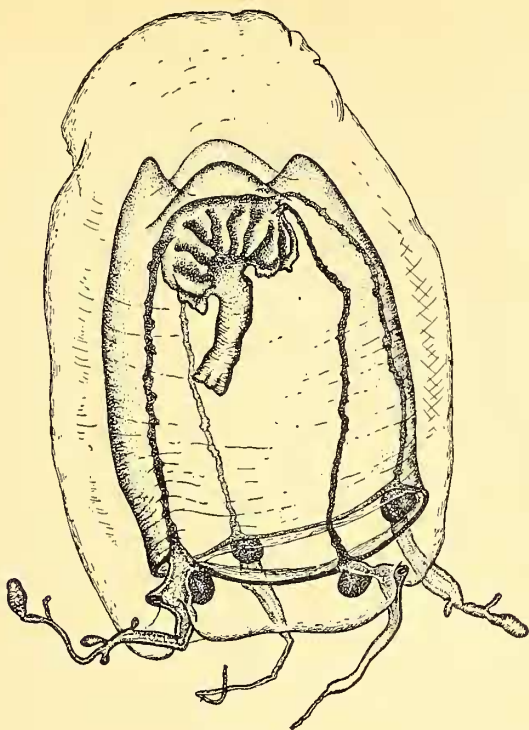
Text-fig. 1.
Zancleopsis dichotoma. Bermudian specimen,
20 mm. high.

A   B
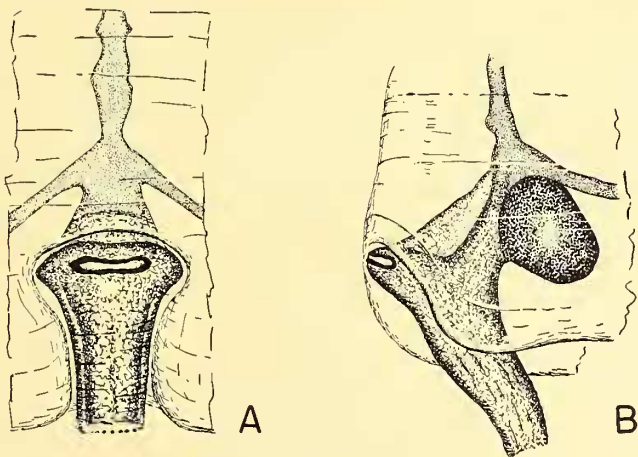
Text-fig. 2.
Zancleopsis dichotoma.   Tentacular bulb.   **A.,** Abaxial
view; **B.,** Lateral view. x about 12.

trace of the nematocyst-ribs so conspicuous in *Zanclea*. The subumbrella occupies about ⅔ the heighth of the bell, with the bell-cavity projecting, pouch-like, apically, in the interradii, in form easier pictured (Text-fig. 1) than described; again much as Kramp figured it for the Pacific species. The four radial canals are of moderate breadth, their margins distinctly jagged (smooth in *tentaculata*). The margins of the circular canal are smooth.

The four subspherical tentacular bulbs, about equal in size, are prominent axially. Just distal to its bulb, the tentacle base is also expanded, abaxially, as a spur (Text-fig. 2) lying in a furrow of the exumbrella, and with a curious cap-like mass of large, clear cells (apparently ectoderm) on its outer (abaxial) side. On its outer angle the spur bears a prominent, long oval ocellus (Text-fig. 2A). The four tentacular filaments are all of about the same length—in the preserved state about ⅓ as long as the bell is high. One pair are simple, the other pair branched. Of the latter, one bears a branch out near the tip, two sessile knobs about mid-way the length of the filament (distal to which the latter narrows abruptly), besides a swelling apparently the forerunner of an additional branch. The other tentacle of this pair bears two small branches, but is so strongly contracted that it is impossible to tell how extensible the latter may have been. The two branched primary tentacles terminate in large knobs. The two secondary tentacles do not, but their tips are in poor condition.

The area of connection between the base of the manubrium and the subumbrella is cruciform, much as described by Kramp for *tentaculata;* its upper ⅓ is thrown into a very characteristic series of vertical folds. These are no doubt the sites of the sexual tissue, as interpreted by Kramp, but eggs not being visible (i.e., the specimen apparently being a male), this point could not be determined positively without microscopic sectioning. In the Pacific specimen of *tentaculata*, there were 3-4 such folds in each interradial sector of the manubrium (Kramp, 1928, p. 41, Fig. 15). In the present specimen the number is greater, 4-6 per interradius, precise enumeration depending on what does, or does not, deserve the name "fold." Below the level of attachment of the radial canals the folds apparently form a continuous series surrounding the manubrium, but as Kramp points out, sectioning would be required to show to what extent the masses of sex tissue are confluent. In the preserved state, the distal tube-like portion of the manubrium hangs to about the mid-level of the bell cavity. But as it is much wrinkled, it is probably contracted, hence may have been considerably longer in life.

After preservation with formalin, manubrium and tentacular bulbs are of an opaque, dull brownish hue; the pigment ring of each ocellus, dull red.

A comparison of Text-fig. 1 with Kramp's (1928, Figs. 14-18) illustrations of *Z. tentaculata* will sufficiently emphasize the close resemblance between the two, especially as regards the structure of the tentacles. The chief differences—probably sufficient to separate two species—are summarized above (p. 102). Minor differences in the outline of the bell and the shape of the manubrium are probably to be credited to the preservative.

BOUGAINVILLIIDAE.

Bougainvillia.

Bougainvillia niobe Mayer.

Bougainvillia niobe, Mayer, 1894, p. 236, Pl. 1, Fig. 2; 1900, p. 42; 1904, p. 11, Pl. 2, Figs. 14-15c; 1910, p. 166, Pl. 18, Figs. 1-3; Bigelow, 1918, p. 368.

Material: Surface, July 11, 1929, 1 specimen, 9 mm. diameter, with medusa buds.

Net No. 562, 914-0 meters, May 10, 1930, 1 specimen, 9 mm. diameter, with medusa buds.

Net No. 738, 1,463-0 meters, June 28, 1930, 1 specimen, 9 mm. diameter, with gonads.

Net No. 812, 1,463-0 meters, August 28, 1930, 1 specimen, 10 mm. diameter, with gonads.

Net No. 862, 1,463-0 meters, September 8, 1930, 1 specimen, 10 mm. diameter, with gonads.

Net No. 915, 549-0 meters, September 19, 1930, 1 specimen, 6 mm. diameter, with medusa buds.

Net No. 935, 1,463-0 meters, September 23, 1930, 1 specimen, 10 mm. diameter, with gonads.

These specimens confirm conclusions earlier reached from the study of the more extensive *Bache* series (Bigelow, 1918, p. 368) as to the relationship of *B. niobe* to other species of the genus, for they fall well within the recorded range of *niobe* in number of marginal tentacles and in branching of the oral tentacles. As in previous collections, the smaller specimens, up to 9 mm. in diameter, bear the medusa buds well described by Mayer (1910), whereas the gonads have so far been found only in specimens of 8 mm. in diameter or larger. In the specimens listed above, as in those of the *Bache* collection, the sex-masses are adradial, in which *niobe* resembles *fulva* and *britannica*. It was not possible to determine on the *Bache* specimens whether or not the masses of sexual tissue were discontinous in the interradii, at the base of the manubrium. This, however, seems definitely to be the case in the specimen from Net No. 862; apparently so in the specimen from Net No. 812 (see list above). Hence, while the other two specimens with gonads are too much contracted to show this feature, it can now be added to the specific diagnosis.

The medusa buds in the smaller specimens add nothing to Mayer's (1910) account, except for confirmation.

I may note also that one specimen (Net No. 562) is infested with the parasitic larval stages of a Narcomedusa, probably *Cunoctantha*.

The large specimens are so much contracted that exact counting of the marginal tentacles is difficult. They appear to range from 13-14 up to 16; in one bundle possibly 18, the latter a somewhat greater number than reported previously. For this same reason, the number of branchings of the oral tentacles can be stated only tentatively; the maximum number of branchings appears to be not less than 8 or 9.

On the basis of cumulative evidence the following diagnosis may now be given for this species: Marginal tentacles, usual maximum 12-16 per bundle at sexual maturity, perhaps up to 18-19; gonads adradial, discontinuous in the interradii and entirely confined to the manubrium proper; manubrium sessile, i.e., there is no gelatinous peduncle; ocelli are present; oral tentacles branch a maximum of 7-9 times. Medium sized individuals may produce medusa-buds. It is not known whether the same individuals produce first buds, then gonads in succession, or whether some individuals exhibit the asexual reproduction only, others the sexual.

The closest ally of *niobe* is the wide-ranging Pacific species, *fulva;* so close in fact, that no constant difference has been found, to separate them, other than the common occurrence of budding in the former, its absence, so far as known, in the latter.

General Distribution: Records for *B. niobe* are so far confined to the waters between southern Florida, Cuba, the Bahamas, and Bermuda. The common occurrence of this species, close to the surface, proves it a shoal water form, hence it is probable that the specimens taken in deep hauls (all with open nets) were picked up not far below the surface.

PANDEIDAE.

Pandea.

Pandea conica Quoy and Gaimard.

Dianaea conica, Quoy and Gaimard, 1827, p. 182, Pl. 6A, Figs. 3-4.
For synonymy, see, Mayer, 1910, p. 118; Hartlaub, 1914, p. 338; Kramp,
    1924, p. 8; Uchida, 1927, p. 214; Ranson, 1936, p. 84.

Material: Net No. 649, 1,646-0 meters, May 29, 1930, 1 specimen, about
17 mm. high.

The single example is much contracted, the margin being strongly re-
curved; gonads, radial canals, and tentacular bulbs are, however, in good
condition, and it is chiefly on the basis of the former that the specimen is
identified as *P. conica.*

The several recent accounts of this species agree that, at maturity, its
gonads form an irregular net-work completely occupying the interradial
areas of the gastric wall (see especially, Mayer, 1910, p. 117, Fig. 63B;
Hartlaub, 1914, Figs. 283, 286; Uchida, 1927, Fig. 38; Ranson, 1936, Pl. 1,
Fig. 2). Conditions in the present specimen suggest a somewhat more ad-
vanced stage in development, for while the upper portion of the manubrium
shows much the type of network—the most distinctive generic feature—
usually figured, this gives place in the distal zone next the lip to an irreg-
ular series of folds and knobs, a formation not shown in any of the earlier
figures, though perhaps indicated by Uchida (1927).

There are 34 or 35 tentacles—a number falling well within the recorded
range, the maximum so far recorded being 44 in a specimen 30 mm. high
(Uchida, 1927). The tentacles also show the characteristic laterally com-
pressed basal bulbs, each with a well marked, dark red, abaxial ocellus,
repeatedly described for *P. conica.*

Earlier accounts have varied as to whether the walls of the radial
canals are smooth (Hartlaub, 1914, p. 339), or more or less jagged (Mayer,
1910, p. 117, Fig. 63; Uchida, 1927, p. 214). In the present example, they
are of the latter type, much as pictured by Uchida (1927) and reported by
Kramp (1928) for a large specimen from Japan. The only feature specifi-
cally characteristic of *P. conica* that is not clearly shown is the ribbing of
the exumbrella with nematocyst ridges. The bell does show a definite ridge
in the radius of each tentacle. But the exumbral surface has been so badly
rubbed, that one cannot be certain whether these ridges actually represent
the locations of nematocyst ribs, or are merely contraction phenomena. But
the specimen agrees so well in all other respects with the accounts of *conica,*
and with good specimens of the latter from Naples, with which I have been
able to compare it, that its identity, as such, seems assured.

General Distribution: *P. conica* has already been found at a station not
far from Bermuda (Bigelow, 1918).[2] Other captures show a wide distribu-
tion, including many localities in the Mediterranean (Kramp, 1924), off
Scotland, the South Atlantic, Japan, and the Philippines.

Vertical Range: Recorded depths of capture indicated that *P. conica* oc-
cupies a considerable depth zone, for while all stages have been found com-
monly at the surface (Kramp, 1924; Ranson, 1936), a fair proportion of
the records have been from nets working down to considerable depths.[3] But
the deep hauls yielding it have all been with open nets, nor are data exten-
sive enough to allow any conclusion as to the lower limit to its normal oc-
currence.

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[2] Identification of this specimen was provisional, but subsequent studies of *P. conica* show that
it fell well within the varietal range of this species.

[3] See especially the table of *Thor* captures, given by Kramp (1924, p. 9).

Pandea rubra Bigelow.

Pandea rubra, Bigelow, 1913, p. 14, Pl. 2, Figs. 1-7; Hartlaub, 1914, p.
   340; Kramp, 1920, p. 4; 1926, p. 96, Pl. 2, Fig. 15; Ranson, 1936,
   p. 81.

Material: Net No. 562, 914-0 meters, May 10, 1930, 1 specimen, about
25 mm. high.
   Net No. 607, 914-0 meters, May 20, 1930, 1 specimen, about 40 mm. high.
   Net No. 613, 1,097-0 meters, May 21, 1930, 1 specimen, about 40 mm.
high.
   Net No. 800 1,463-0 meters, July 15, 1930, 1 specimen, about 40 mm.
high.

The specimens from Net Nos. 562, 613, and 800 are in good enough
condition to show that they agree closely, even as to details, with the orig-
inal series from the North Pacific, and with those subsequently collected in
the North Atlantic by the *Armauer Hansen* (Kramp, 1920; 1926.) The most
diagnostic morphological features of this species, as contrasted with its
relative *P. conica,* are its lack of exumbral nettle ribs, the thin bell wall, the
very complex and fine meshed network formed on the walls of the manu-
brium by the development of the gonads, the complexly crenulated lips, the
small number of tentacles, and the large size attained at maturity. Another
difference is that most accounts of *conica* credit it with ocelli, whereas such
organs have not been detected in any of the specimens of *rubra* so far seen.

The largest example yet recorded (from the Pacific) about 75 mm. high,
had about 20 tentacles (Bigelow, 1913); Pacific examples of 35-47 mm. had
14-18.   Present indications are that the number of tentacles may average
somewhat smaller in medium-sized examples from the Atlantic than from
the Pacific, for in 2 Bermudian specimens about 38-40 mm. high, and in
one of Kramp's (1920; 1926), of about the same size, the number ranged
from 12-14.   But larger series might well show that there is actually no
regional difference in this respect. Specimens 25-31 mm. high (1 Pacific,
2 Atlantic) may have 8 (Kramp, 1926, p. 96), 9 (Bermudian specimen, Net
No. 562), or 12 or 13 tentacles (Bigelow, 1913, Pl. 2, Fig. 6).

The gonads of *P. rubra* are extremely characteristic, the sexual con-
volutions of the manubrium taking the form of an extremely fine and nu-
merous-meshed network; comparison of a photograph of a Pacific specimen
(Bigelow, 1913, Pl. 2, Fig. 2)—which would equally well represent the Ber-
mudian specimen from Net No. 613—with illustrations of *P. conica* by
Mayer (1910, Fig. 63) and by Ranson (1936, Pl. 1, Fig. 2) will illustrate
how widely the two species differ in this respect; how widely, in fact, *rubra*
differs from any other pandeid yet known. Seen from the inner side, the
sexual thickenings appear as a great number of knobs.

The most arresting feature of *P. rubra,* among its relatives, is that it
shows extreme development of what might now be termed "bathypelagic"
pigmentation.   The Bermuda specimens about 40 mm. high show the same
reddish or chocolate brown coloration as the Pacific specimens of the same
size or larger, the entire manubrium, tentacles, and subumbrella surface
being densely pigmented, with the more palely colored radial canals show-
ing as pale bands.   In the Bermudian example of 25 mm., however, in
which the manubrium and tentacles are equally densely colored, the sub-
umbrella is pigmented only in the immediate vicinity of the base of the
manubrium, so that the pigmented canals—radial and circular—show as
dark bands in the transparent bell, as was also the case in the smaller of
the Pacific specimens.   As Pacific examples of intermediate size (35-40
mm.) showed an intermediate stage (Bigelow, 1913, p. 16), it appears that
it is not until the medusa is well-grown that pigment spreads out over the
subumbrella—perhaps accompanying a descent into deeper water.

Ranson (1936, p. 82) does not consider the coloration diagnostic in this genus. The pigmentation of *P. rubra* is, however so peculiar in its density and opacity, and in its eventual extension over the subumbrella (quite apart from the precise shade of color), and *P. rubra* differs so widely in these respects from *P. conica*, that it must be regarded as a specific characteristic even though it may not be a safe criterion for identification except for large specimens.

General Distribution: Previous records include high latitudes in the northwest Pacific and Bering Sea (Bigelow, 1913); and, more recently, two oceanic stations to the west of Ireland (Kramp, 1920). The captures at Bermuda now make it likely that its range will finally prove to be as extensive as that of other bathypelagic medusae.

Vertical Range: The shoalest of the 6 hauls that have so far yielded it was from 411-0 meters (*Albatross* Sta. 4800); others have been from 549-0 meters or deeper.

BYTHOTIARIDAE.

Heterotiara.

Heterotiara anonyma Maas.

Heterotiara anonyma, Maas, 1905, p. 19, Pl. 3, Figs. 19-21; Bigelow, 1909, p. 216, Pl. 41, Figs. 12-13; 1913, p. 25; 1918, p. 382; Mayer, 1910, p. 107, 489; Vanhöffen, 1911, p. 211, Pl. 22, Figs. 3, 4; Hartlaub, 1914, p. 350.

Material: Net No. 79, 1,280-0 meters, May 8, 1929, 1 very fragmentary specimen, about 20 mm. high by 17 mm. in diameter.

Net No. 977, Surface, May 12, 1931, 1 specimen, 13 mm. high by 9 mm. in diameter, with 10 tentacles.

The specimen from Net No. 977 is in excellent condition. As regards size, in relation to the number of tentacles, it falls well within the range already recorded (Bigelow, 1913, p. 26; 1918, p. 382; 1919, p. 287.

The larger specimen is in such poor condition that identification is only tentative. Its general appearance seems, however, to warrant reference to *Heterotiara,* and its large size to *H. anonyma* rather than to *H. minor.*

General Distribution: Previous Atlantic records are between Florida, the Bahamas, and Cuba (Bigelow, 1918). Elsewhere, it is known from Malayan waters, the Indian Ocean and several localities in the Pacific, South and North, including Bering Sea (for list of Pacific localities, see Hartlaub, 1914, p. 351).

Vertical Range: The recorded vertical range includes various depths from the surface downward. The comparative frequency with which the *Bache* took it shoaler than 100 meters (Bigelow, 1918, p. 382), makes it likely that specimens from deep hauls with open nets were actually taken in the upper water layers.

Calycopsis.

Calycopsis sp.?

Material: Net No. 959, 914-0 meters, September 29, 1930, 1 specimen about 22 mm. high; 1 specimen, much crumpled, about 9 mm. high.

The larger specimen is fragmentary, having lost all but the cruciform base of the manubrium. And it apparently represents an abnormality of the same type as pictured by Kramp (1924, p. 15, Fig. 11B, 11D) for *Bythotiara murrayi,* for the canals are connected in an irregular network,

the arrangement differing on the halves of the bell. To attempt to give it a specific name would only add to the difficulties with which the student of the genus is faced.

LEPTOMEDUSAE.

LAODICEIDAE.

Chromatonema.

The systematic location of this genus, originally described by Fewkes (1882), is still a moot question: it is placed by Kramp (1919; 1933) among the Laodiceidae, which by common consent, are the leptomedusan group most closely related to the higher Anthomedusae, whereas Ranson (1936) refers it to the latter, as a member of the Williidae. Discussion of this point necessarily revolves chiefly around the relationship of the gonads to the gastrovascular system, i.e., whether the perradial diverticula from the corners of the stomach, along which the sexual tissue is developed, are actually part of the manubrium, whether they are merely the dilated proximal sectors of the radial canals, or whether (as I believe) no sharp distinction can be drawn between gastric and canalar portions. This last view has already been proposed by Kramp (1933, p. 552) who says, for the Laodiceidae as a whole, that the separation of the gonads from the manubrium is not "durchgeführt." The Bermudian series are not in good enough condition to throw light on this point. But successive growth stages in the closely allied *C. erythrogonon*, from the Pacific (Bigelow, 1909), show, on the one hand, that the development of the gonads does take place along the radial canals (cf. Bigelow, 1909, Pl. 39, Fig. 6 with Figs. 2-3), but, on the other hand, that as the sex masses increase in size and complexity, the canal-sectors that they occupy expand in breadth and so become morphologically incorporated into the cruciform angles of the manubrium proper. Thus, it is only distal to the extremities of the gonads that the canals continue to retain their narrow tubular nature. It also seems probable from the corresponding expansion of entodermal pigment that Kramp (1919) was correct in crediting a digestive function to the expanded proximal portions.

If this view be correct, the primary question is no longer whether we are to regard *Chromatonema* as a Leptomedusa or as an Anthomedusa, for it bridges the gap, but to which of the borderline groups it belongs, or is most closely related. Basing the decision chiefly on the marginal sensory clubs, it seems wisest to follow Kramp (1919; 1933) in referring it to the Laodiceidae—at least, provisionally. But future study may well show that *Chromatonema* deserves a separate family, for as Kramp (1919) has emphasized, its gonads are fundamentally similar to those of *Calycopsis*, rather than to those of *Laodicea* or *Ptychogena*. I cannot follow Ranson (1936) in referring it to the Williidae (if his own definition of the latter is to be accepted), because he confines this family to forms lacking a circular canal, which is present in *Chromatonema* as Kramp (1919, p. 9) has shown and as Ranson (1936, p. 103) himself remarks, and because the typical members of the Williidae (*Willia* and *Proboscidactyla*) lack marginal organs other than tentacles.

Chromatonema rubrum Fewkes.

Chromatonema rubrum, Fewkes, 1882, p. 305, Pl. 1, Fig. 41.

For subsequent references, see Kramp, 1919, p. 7; 1933, p. 552; Ranson, 1936, p. 102.

Material: Net No. 368, 1,280-0 meters, August 14, 1929 and Net No.

959, 914-0 meters, September 29, 1930, 2 very fragmentary specimens, respectively about 17 and 15 mm. in diameter.

One of these specimens still bears fragments of a few tentacles, though no cordyli; the other has lost the marginal zone altogether. Identity seems, however, reasonably assured by what remains of the gonads, which are of very characteristic appearance in this genus.

The Bermuda capture extends the known range of *C. rubrum* southward, previous records being west of the Azores (Ranson, 1936); off the American continental slope in Latitude about 40° N. (Fewkes, 1882); and at numerous localities farther north, including Davis Strait (Kramp, 1919, Chart I, p. 13).

The depths of capture of the Bermudian specimens are in line with previous experience that *C. rubrum* inhabits chiefly the mid-depths, the great majority of captures (all with open nets) having been in hauls reaching down to at least 700 meters, and as Kramp (1933, p. 553) remarks "nur ein paarmal in höheren Wasserlagen."

AEQUORIDAE.

Aequorea.

The few Aequoreas in the collection represent the subdivision of the genus in which the stomach is only 1/4-1/5 as broad as the diameter of the disc.   In contrast to the multiplicity of names under which large-stomached Aequoreas have appeared in literature, the small-stomached group includes only two named forms, *tenuis* and *floridana*. The first of these is now generally accepted as a good species (Bigelow, 1913; Kramp, 1933; Ranson, 1936), size of stomach having proved one of the most dependable characters in this widely variable genus.   But the status of the second has remained doubtful, awaiting critical examination of the supposed differences—all minor—between it and *tenuis*.   The Bermuda specimens agree so closely with A. Agassiz's (1865) account of *floridana* as to leave no doubt of their identity with the latter.   And the need of giving them a name makes pertinent a decision as to the relationship of *floridana* to *tenuis;* names which appeared on the same page in the original publication.   According to the original accounts, and to Mayer's (1910) more recent comparison, the chief differences between the two are that *floridana* has more tentacles at a smaller size, about four times as many otocysts as tentacles instead of an equal number, a somewhat smaller stomach (about 1/7 instead of 1/5 as wide as the diameter of the bell), and that its radial canals are very narrow, its tentacles minute.[4] Hargitt (1905), however, had already shown that in *tenuis* from Woods Hole (i.e., from the type region) numerical characters are all highly variable. Thus, a specimen of only 36 mm. may have even more tentacles than one of 47 mm. Canals not only vary in number, but show much irregular branching and anastomosis.   The number of otocysts (described by A. Agassiz as alternating regularly with the tentacles) may be one, is often two, and sometimes even more between every two tentacles and series of typical *tenuis* from Woods Hole in the collection of the Museum of Comparative Zoology, similarly show from 1-4; most frequently 2 or 3; the number depending, it seems, on the distance apart of the large tentacles, and on how many rudimentary tentacles there are in the interspaces.   I may note in passing, that while A. Agassiz (1865, p. 96, Fig. 138) stated that there is always a single otocyst between 2 tentacles in *tenuis*, the segment of margin he illustrated was one in which two large tentacles stood close together with no small ones intervening.

The contracted condition of the specimens in the present collection

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[4] Mayer's (1910, Pl. 43, Fig. 6) illustration of *Ae. floridana* is obviously labelled incorrectly, for it shows a very wide stomach.

makes it difficult to make sure of the total number of otocysts. But in other specimens from Bermuda, in the collection of the Museum of Comparative Zoology, there are from one to three between every two large tentacles, most frequently one or two in the sectors on the margin on which the otocysts are still intact, which agrees with the Woods Hole specimens of *tenuis*. And the number of small tentacles, between 2 adjacent large ones, varies from none to an observed maximum of six, usually 1-3.

Evidently, then, one can no longer invoke numerical precision in the number of otocysts relative to tentacles as an alternative character between *tenuis* and *floridana*. Neither can the number of large tentacles finally developed, for while, by published accounts, this is somewhat larger for *floridana* (up to 100) than for *tenuis* (up to 90), there is no discontinuity in this respect. Comparison of the Woods Hole series, just mentioned, with the Bermudian specimens shows, however, that at diameters of 24-35 mm. (*tenuis* is only half grown at this size), *tenuis* consistently has significantly fewer large tentacles than *floridana*, the number in the one case ranging from 43-58, in the other from 63-103. And a still sharper distinction appears in the number of canals, for while in the *tenuis* within this size range that I have examined, the number of complete canals arising from the stomach, varies from 22-31 (plus 1-4 blind centrifugals in 5 of the seven specimens), which corroborates previous reports of 24-32, the number in the Bermuda specimens is 16 in every specimen (large or small) where countable, except for two (respectively of 25 and 28 mm.) in which it is 15. And no blind centrifugals are to be seen in any. A. Agassiz's (1865, Fig. 139) illustration of *floridana* also shows 16 complete canals, though with one short centrifugal also, besides indications of an early stage in formation of several more, while Mayer (1910, p. 330) reports 16-24 complete canals.

Thus it appears that while occasional specimens of *floridana* may have as many canals as an occasional—perhaps stunted—*tenuis*, the number is usually only ½ to ⅔ as great in the former as in the latter, with strong indications of a normal determinate number of 16 in the one case, of 32 in the other. And this difference seems sufficient to warrant recognition of both species. A minor difference is that *floridana* (so far as known) is full grown and has its maximum number of large tentacles at a maximum reported diameter of only about 50 mm.; whereas *tenuis*, at Woods Hole, is known to reach a diameter of 100 mm. (Mayer, 1910, p. 332).

Aequorea floridana L. Agassiz.

Rhegmatodes floridanus, L. Agassiz, 1862, p. 361; A. Agassiz, 1865, p. 97, Fig. 139.

Rhegmatodes floridana, Haeckel, 1879, p. 223.

Aequorea floridana, Mayer, 1910, p. 330; Bigelow, 1913, p. 37; 1919, p. 309.

Material: Net No. 840, Surface, September 3, 1930, 1 specimen about 19-20 mm. in diameter, stomach diameter, 4 mm., 16 canals, 72 tentacles; 1 specimen, 23-24 mm. in diameter, stomach diameter about 5 mm., 16 canals and about 50 large tentacles. As the margin in each case is damaged, exact measurement of diameter is not possible.

Also, 16 other Bermudian specimens, 12-37 mm. in diameter (besides fragments) collected in the summers of 1903, 1904, 1911 and 1916, now in the Museum of Comparative Zoology.

The following tabulation for the Bermuda specimens is pertinent to the foregoing discussion of the relationship of *Ae. floridana* to *Ae. tenuis*.

Date of Collection.	Approximate Diameter.	Approximate Diameter of Stomach.	Approximate Number of Large Tentacles.	Canals.
1904	12	3	37	16
1904	15	3	45	16
1930	20	4	72	16
1930	23	5	50	16
1904	23	6	63	16
1904	25	5	67	16
1911	25	6	63	15
1911	28	7	46	15
1911	28	5	81	16
1911	33	7	74	16
1916	33	7	87	16
1916	33	7	85	?
1904	35	7-8	83	16
1916	37	8	103	16

Relative counts of large tentacles and of small cannot be precise, there being no sharp demarcation between the latter and rudimentary knobs of various sizes, the variety in size of which is evidence that while some would have developed into large, others would have remained permanently rudimentary.

The specimens of 12-15 mm. have no gonads; in those of 20-23 mm., gonads have appeared on the outer ⅓-½ of the radial canals; in those of 25-28 mm., they occupy the outer ½-⅔ and the outer ⅔-¾ in the larger specimens of 33-37 mm.

In *Ae. tenuis* of corresponding sizes, the gonads occupy about the same sectors of the canals, but with continued growth they finally come to occupy nearly the whole length of canals, though (as Mayer, 1910, p. 332, remarks) "not quite reaching the circular canal."

According to Mayer (1910, p. 330), the stomach is relatively smaller in *floridana* (only 1/7 as wide as the disc) than in *tenuis* (about 1/5 the width of the disc). However, A. Agassiz (1865, Fig. 139) pictures its greatest diameter as about 1/5. And as the preceding tabulation shows, it ranges about 1/4-1/5 the diameter of the disc in the Bermuda specimens. But since the stomach is rarely—if ever—circular, its breadth depends on what particular radius be chosen for measurement. Total diameter similarly depends on the degree of contraction (cupping) or relaxation of the disc.

General Distribution: So far as I am aware, previous records of small-stomached Aequoreas referable to *floridana* have been confined to the waters around the southern extremity of Florida. Bermuda is thus a considerable extension of the known range.

TRACHOMEDUSAE.

OLINDIIDAE.

Olindias.

Recent studies of considerable series from different parts of the world (Bigelow, 1909; 1919; Mayer, 1910; Neppi and Stiasny, 1913) have made it reasonably certain that the two named forms from the western Atlantic (*sambaquiensis* F. Müller and *tenuis* Fewkes) represent but a single species, for the supposed differences between them in number of tentacles, of marginal knobs, and of blind centripetal canals, and in the diameter of the disc indicate, at most, that *tenuis* is a dwarf race of *sambaquiensis,* or that the de-

scriptions of the former have been based on specimens that had not attained their maximum growth and development. It has in fact been repeatedly suggested that both of these are simply varieties—if as much—of the well-known *O. phosphorica* of the Mediterranean. And the necessity of naming the Bermudian example listed below makes discussion of this question pertinent.

The only ostensible differences between *phosphorica* and *sambaquiensis* are that the original account of the latter (Müller, 1861) credits it with a larger number of secondary tentacles (200-300) and of centripetal canals (21-27 per quadrant), than have ever been recorded for *phosphorica*, for which the maxima are 100-120 tentacles and 19 centripetal canals in one quadrant (for tabulation of numerical characters, see Bigelow, 1909, p. 109; Mayer, 1910, p. 353). That is to say, *phosphorica* bears the same sort of relationship to *sambaquiensis* as does *tenuis* to *phosphorica*. By present indications it is not possible to make any definite specific separation, within this series, because the three forms intergrade in numerical characters. On the other hand, to unite the three definitely under one name, would obscure the very interesting fact that all the records from the West Indian-Bermudian region are for the *tenuis* (or to some extent paedogenetic) form, which is not known to occur at all in the Mediterranean. Neither, on the other hand, has *Olindias* from the latter sea, ever been found to attain the extreme development described for the Brazilian form. The case, analogous to that of the representatives of *Charybdea* from these same regions (p. 137), seems best handled taxonomically, by the recognition of subspecies. For further discussion of the reasons for this procedure, in the case of geographic races of medusae, see page 137.

Olindias phosphorica tenuis Fewkes.

Halicalyx tenuis, Fewkes, 1882, p. 277, Pl. 7, Fig. 15.
To the references given by Mayer, 1910, p. 354 (*"Olindias tenuis"*), add:
Olindias phosphorica [Partim], Bigelow, 1919, p. 317.
Olindias tenuis, Boone, 1933, p. 32.

Material: Net No. 840, Surface, September 20, 1929, 3 specimens, approximately 10, 10, and 25 mm. in diameter.

The larger specimen has large gonads, between 45 and 50 primary tentacles, and about 40 centripetal canals, the contracted and recurved state of the margin preventing exact enumeration. The chief interest of the series is as cumulative evidence that the Bermudian-West Indian representatives of *O. phosphorica* are characterized by fewer primary tentacles and canals at maturity than are their Mediterranean relatives; consequently that the recognition in nomenclature of *tenuis*, as a local subspecies, is justifiable. Owing to the condition of the large specimen, I was not able to count the secondary tentacles.

General Distribution: *O. tenuis* has already been reported from Bermuda (Bigelow, 1909, p. 109); other records are from the Bahamas and the coast of southern Florida (Fewkes, 1882; Mayer, 1910; Boone, 1933).

TRACHYNEMIDAE.

Rhopalonema.

Rhopalonema velatum Gegenbaur.

Rhopalonema velatum, Gegenbaur, 1856, p. 251, Pl. 9, Figs. 1-5.
For synonymy, see Bigelow, 1909, p. 129; Mayer, 1910, p. 378; Thiel, 1936, p. 10.

Material: Net Nos. 32, 35, 39, 43, 44, 67, 69, 97, 98, 100, 102, 362, 581, 620, 632, 634, 682, 720, 730, 793, 915, 916, 945, 959, 967; hauls at 549-0 to 1,829-0 meters; 39 specimens, 6-12 mm. in diameter; 1-5 specimens per haul.

These specimens, all of which are more or less fragmentary, call for no special comment, this being one of the best known of Trachomedusae. I need merely note that as all of them are large enough to show the situation of the gonads, there is no possibility that the list includes any examples of *Sminthea eurygaster*, a species somewhat similar in appearance, and which Thiel (1936, Fig. 2) has recently shown to be much more generally distributed on the high seas than formerly supposed.

General Distribution: *R. velatum* was to be expected near Bermuda, there being many previous records for the eastern side of the Sargasso Sea region, as well as elsewhere over the warmer belts of all three oceans, including also the Mediterranean and Red Sea. For a recent chart of distribution, see Thiel, 1936, Fig. 1.

It is interesting that 108 hauls shoaler than 549-0 meters did not yield it, for it often occurs close to the surface, with its center of abundance shoaler, in general, than 100 meters (Thiel, 1935, Fig. 21).

Pantachogon.

The definitions for this genus adopted by Mayer (1910), also recently by Broch (1929) and by Thiel (1932), would likewise include the medusa reported here (p. 117) as *Colobonema*. But for reasons stated on page 116, it seems to me preferable to retain the latter genus as distinct, because of the peculiar order in which its tentacles are developed, and because of the structure of its radial canals. The structure of its tentacles may perhaps be of generic significance, likewise. Opinions have also differed as to whether the generic limits of *Pantachogon* should be interpreted broadly enough to include the various species usually reported as *Homoeonema*, in which the gonads are localized along restricted sectors of the radial canals (Bigelow, 1913, p. 44), or should be restricted to forms in which these organs are developed more diffusely along the whole length of the canals (Broch, 1929; Thiel, 1932, 1936; Ranson, 1936). As the present collection contains representatives of the latter sort, only, it does not aid in the solution of this question.

The group with diffuse gonads includes three named forms, *haeckeli* (Maas, 1893), *rubrum* (Vanhöffen, 1902), and *scotti* (Browne, 1910). I have already expressed doubt as to whether the first two could be separated, the color being the only difference. As Ranson (1936) again emphasizes, successive studies of considerable series have revealed no anatomical differences whatever between them, hence he has now united them provisionally, Thiel (1936) definitely, and I believe with good reason. I may add that the capture near Bermuda of several specimens, lacking any trace of pigment (i.e., of the *haeckeli* type), now answers the last argument in favor of considering the two color-forms as distinct, i. e., that the colorless *haeckeli* was restricted to high latitudes. Nomenclatural rules require the choice of *haeckeli* Maas as the name for the joint species, because Maas' account, with clearly recognizable illustration showing the gonads and tentacles correctly, was published many years prior to the description of *rubrum* (Vanhöffen, 1902).

P. scotti, an Antarctic species, is separated from *haeckeli* by much more numerous tentacles (104-128, contrasted with a maximum of 64 in *haeckeli*). And so many specimens of the latter have now been examined that this difference seems established.

Pantachogon haeckeli Maas.

Pantachogon haeckeli, Maas, 1893, p. 17, Pl. 1, Fig. 2; 1904, p. 29;
    Mayer, 1910, p. 389; Bigelow, 1913, p. 44, Pl. 3, Figs. 4-8; Broch,
    1929, p. 503; Thiel, 1932a, p. 152; 1936, p. 26.
Pantachogon rubrum, Vanhöffen, 1902a, p. 63, Pl. 9, Fig. 9, Pl. 10,
    Figs. 19-20, Pl. 11, Fig. 25; Maas, 1905, p. 55, Pl. 10, Fig. 66;
    Mayer, 1910, p. 389; Kramp, 1913, p. 274; 1914, p. 433; 1920, p. 5;
    1924, p. 22; Bigelow, 1913, p. 44; Browne, 1916, p. 195; Broch,
    1929, p. 504; Thiel, 1931, p. 330; 1932a, p. 153; Ranson, 1936, p.
    147.
Pantachogon rubrum [Partim], Thiel, 1936, p. 24.

Material: Net Nos. 36, 42, 52, 64, 234, 296, 539, 552, 554, 575, 582, 598,
628, 648, 657, 658, 659, 666, 684, 685, 691, 695, 698, 709, 717, 718, 736, 739,
742, 757, 780, 789, 805, 809, 854, 862, 864, 866, 881, 897, 916, 964; 549-0 to
1,829-0 meters; 65 specimens; 1-5 per haul.

Also, 12 very fragmentary specimens, from Net Nos. 556, 640, 698, 709,
721, 748, 862, 929; 1,280-0 to 1,646-0 meters, are provisionally referred to
this species.

The specimens are all more or less fragmentary—most of them very
much damaged—but those included in the first of the two preceeding lists
have enough of the margin and of the subumbrella intact to show that the
tentacles are so spaced as to accord with the number characteristic of this
species (maximum, 64), and that the radial canals are of even bore through-
out their lengths. I have also been able to compare them with the series
collected by the *Albatross* in the northwestern Pacific (Bigelow, 1913).

Tentacles: Vanhöffen (1902a) counted 7 tentacles per octant, between
every two perradials, in all his specimens. Maas (1905), however, found
smaller numbers in some octants, i.e., intermediate stages in development.
And the Bermuda series again illustrates this, for while the sub-radials are
seven in number in most of the octants in which complete counts can be
made, only 6 are to be seen in some octants. And one specimen seems to
have not more than 6 in any octant, i.e., a total of only 56. On the other
hand, a greater number than 7 sub-radials has never been found in any
octant, nor have additional tentacular bulbs been observed. That the num-
ber is determinant in *Pantachogon* (as it is in *Colobonema*) thus seems
sufficiently established. The order of development of the different series of
tentacles has not been traced; nor is this point clarified by the present
series, preservation not being good enough for dependence to be placed on
differences in size between different tentacles. It is, however, suggestive
that a tentacle does not always stand exactly opposite a canal, i.e., it appears
that in some cases none can be described as strictly "perradial;" neither
are those most nearly opposite the canals appreciably larger than the others.

An interesting question, still awaiting answer, is whether the tentacles
of *Pantachogon*, like those of *Colobonema*, are stump-like, as suggested by
the fact that they have been very short, and of sub-equal length, in all the
specimens so far examined, or whether Maas (1905) was correct in his
suggestion that they are of ordinary filamentous type, but so easily broken
off that all except the bases have been lost. None of the Bermudian and
northwest Pacific specimens are in good enough condition to settle this
point, though the general appearance of the tentacles—especially the fact
that in many cases, they are square tipped—favors the second alternative.

Gonads: In one small specimen, about 8 mm. high, in which the gonads
are intact, they represent about the same early stage in development illus-
trated for a North Pacific specimen of corresponding size (Bigelow, 1913,
Pl. 3, Fig. 5). In the larger specimens, the gonads have either been lost

entirely, or are represented by fragments only, here and there along the canals.

Musculature: The circular musculature of the subumbrella is strongly developed (Bigelow, 1913; Ranson, 1936); a development as striking, in fact, as it is in *Colobonema*. In *Pantachogon*, as in *Colobonema*, however, the musculature is not only entirely discontinuous along the lines of the radial canals, but terminates, apically, at the level where the general contour of the subumbrella changes from sub-cylindrical to domed, leaving a considerable clear space surrounding the base of the manubrium. And Ranson (1936) has recently pointed out that the outlines of the apical ends of the interradial muscular fields provide at least a specific character, being transversely truncate in *P. haeckeli*, as appears clearly in the few Bermuda specimens in which the musculature is still intact, whereas in *Colobonema* they are ovoid, corresponding to the contours of the interspaces between the apically expanded radial canals (p. 118). The latter, as Ranson (1936) has emphasized, are narrow and of uniform caliber, throughout their lengths, from bell margin to union with the manubrium, contrasting strongly with their state in *Colobonema*.

Color: Occasional specimens show a pinkish tinge. But the few in which the subumbral musculature is more or less intact are colorless: interesting evidence, as noted above (p. 114), that the unpigmented form of this species, as well as the rosy-colored, occurs in the warm belt of the North Atlantic. Thiel (1936, p. 24), in fact, has already shown that the two may exist side by side, the *Meteor* having taken one of each at a station in the South Atlantic. No recent student of *Pantachogon* has considered this color difference a sufficient ground *per se* for specific separation. But it is an interesting question, how the existence of the two color phases is to be interpreted. As the present series throws no light on this point, I need only note that the pigmentation of the rosy form (*P. rubrum,* auct.) is not of the peculiarly dense and opaque sort characteristic of many bathypelagic medusae.

General Distribution: Locality records for *P. haeckeli*, as here defined, are widespread in the Atlantic, including Spitzbergen, Irminger Sea and Davis Strait in the north, sundry localities off Ireland, in the Bay of Biscay, and in the region between the Canaries, Azores, and Gibralter; the Mediterranean; the eastern side of the tropical and South Atlantic south to Lat. 64° S.; the Antarctic (Weddell Sea); South and North Indian Oceans and Red Sea; Malaysia; and the extreme northern Pacific including Bering Sea and the Sea of Okhotsk. With the Bermuda records extending the known range to the western Sargasso Sea,—the nearest previous record was in mid-Atlantic—*P. haeckeli* is evidently world wide in the ocean basins, right up to the subpolar zones.

Vertical Range: The great majority of captures have been in open nets working as deep as 500-0 meters, the only exception being a single young specimen taken by the *Valdivia* in a haul from 60 meters (Vanhöffen, 1902).

Colobonema.

There has been much discussion recently as to whether *Colobonema* is generically separable from *Pantachogon*. Thiel (1936) at the one extreme, has even included its unique representative in the synonymy of *P. rubrum* (= *P. haeckeli*). But this seems definitely precluded not only by the constant difference in the number of tentacles, but also by the structure of the proximal sectors of the radial canals. Other students who have recently written of *Colobonema* (Bigelow, 1913; 1919; Kramp, 1924; Broch, 1929; Ranson, 1936) have therefore retained it as a separate genus, either definitely or provisionally. And that course is followed here.

The question what specific name should be applied to the one known representative of *Colobonema* is one that will not down, because a final an-

swer depends on decision as to the accuracy, or the reverse, of the published description of a specimen no longer extant. Accepting Maas' (1905) subsequent statement that his earlier (1897) account of his *Homoeonema typicum*, which credited the latter with more than 32 tentacles, was an error resulting from the poor condition of the specimen, Mayer (1910), Uchida (1928), and I (Bigelow, 1913; 1919) have used this specific name, for in all other respects, Maas' *typicum* appears to resemble the form later described by Vanhöffen (1902a) as *Colobonema sericeum*. Kramp (1920; 1924), Broch (1929), and Ranson (1936), however, take the opposite view, that Maas' (1897) original *typicum* cannot be identified with *sericeum*, hence use the latter name.[5]

The present series adds nothing toward solution of this nomenclatural puzzle, beyond the opportunity for pointing out that choice of *typicum* as the specific designation has the advantage of providing a resting place for a name which is likely otherwise to remain permanently without connection with any actually existant medusa.

Colobonema typicum Maas.

Homoeonema typicum, Maas, 1897, p. 22, Pl. 3, Figs. 1-3.

For early synonymy, see Mayer, 1910, p. 385.

It has been referred to, subsequently, under the following names:

Colobonema sericeum, Kramp, 1920, p. 5; 1924, p. 28; Ranson, 1936, p. 152, Pl. 2, Figs. 14-15.

Homoeonema (*Colobonema*) *sericeum*, Broch, 1929, p. 500.

Colobonema typicum, Bigelow, 1913, p. 46; 1919, p. 322.

Homoeonema typicum, Uchida, 1928, p. 81.

Material: Net Nos. 26, 39, 94, 95, 99, 105, 240, 292, 293, 295, 296, 400, 434, 565, 597, 605, 606, 607, 610, 625, 626, 637, 641, 653, 680, 732, 760, 777, 802, 805, 813, 853, 867, 874, 937, 939, 964; 732-0 to 1,829-0 meters; 47 specimens; 1-3 per haul, mostly in poor condition.

The specimens range from about 8 to about 33 mm. in heighth. Features especially to be examined on any considerable series of this species that may now come to hand, are: (a), number and order of appearance of the tentacles, whether as constant as earlier records have indicated; (b), number of otocysts; and (c), contours of the proximal parts of the radial canals, which Ranson (1936, Pl. 2, Fig. 14) has found to differ significantly from those of *Pantachogon*.

Tentacles: Successive examinations have yielded cumulative evidence, not only that the final number of tentacles in this species is 32, but that variations from this number are so unusual that none has been found among 123 specimens collected by the *Valdivia* (Vanhöffen, 1902a) *Siboga* (Maas, 1905), *Research* (Browne, 1906), *Albatross* (Bigelow, 1909; 1913; 1919), *Thor* (Kramp, 1924), and by the Prince of Monaco (Ranson, 1936). The peculiar order of development—perradials, adradials, and finally interradials —first reported by Maas (1905), has proved equally unvarying, judging from the relative sizes of the different orders of tentacles on small and medium-sized specimens. Both these findings are further corroborated by the present series, for in every octant on which they can be counted, there is the usual interradial, and pair of adradials in the larger specimens. In one of the smaller specimens about 20 mm. high (Net No. 26), the interradial has not yet appeared in one of the octants, while in 6 of the other octants[6] it is represented by a rudimentary knob only, illustrating a stage between that in which the per- and adradials alone have appeared (Maas,

[5] The species subsequently described by Maas (1905) from the *Siboga* collection, as *typicum*, undoubtedly was identical with Vanhöffen's *sericeum*.
[6] The margin of the eighth octant has been torn off.

1905, Fig. 64), and the final stage in which the interradials are also well developed.

In all specimens so far examined (including the Bermuda series) the tentacles have been short, stump-like. And it seems now established that this is normal, and not the result of mutilation, for in the better preserved specimens the tips are rounded and apparently uninjured, i.e., with their ectodermal covering complete. And the fact that in large specimens the members of the per- and adradial series (sometimes the interradials also) are all about equal in length, suggests that they are but little extensible.

Otocysts: The otocysts of this species must be very easily detached, for only in one case has a single otocyst been detected, among the earlier collections (Bigelow, 1919, p. 323). One of the Bermuda specimens (Net No. 26) also bears one otocyst—agreeing in structure with the earlier account—between a per- and an adradial tentacle. But I have not been able to detect even a trace of any others, in this, or on any of the other specimens. To determine positively whether otocysts normally alternate with tentacles, as earlier observations suggest (Bigelow, 1913, p. 321), requires examination of specimens with undamaged margin.

Radial Canals: Ranson (1936, p. 154, Pl. 2, Fig. 14) has recently pointed out (what seems to have been overlooked previously) that the radial canals of *Colobonema* are expanded proximally so that their walls are in close contact (though discontinuous) in the interradii across the domed apex of the subumbrella, narrowing again toward their union with the narrow base of the manubrium, which gives characteristic ovoid contours to the apical ends of the 8 muscular zones. The better preserved of the Bermuda series corroborate this interpretation, so far as can be determined from surface views, though in all cases the base of the stomach is damaged.

General Distribution: *Colobonema*, as distinguished from *Pantachon haeckeli*[7] had been taken already at many stations in regions as widely scattered, as the central Sargasso Sea; the eastern North Atlantic; west of Ireland; between the Azores, Canaries, and the coast of Spain; Straits of Gibraltar; Mediterranean; equatorial and South Atlantic down to Latitude 42°S.; the Indian Ocean from Lat. 9°N. to Lat 34°S.; Malaysian region; Philippines; Japanese waters; and the eastern tropical Pacific. It is, in short, cosmopolitan in the warm and temperate belts, at appropriate depths, but has not yet been reported from Arctic or from Antarctic latitudes.

Vertical Range: So far as I have been able to learn, the shoalest haul that has so far yielded *Colobonema* was with an open net, from about 241-0 meters, most of the captures (all but one with open nets) being from hauls deeper than 500-0 meters; and there is one record from a closing net from 900-1,500 meters. Its bathypelagic habit is thus well established.

Crossota.

Crossota, originally classed with the Ptychogastridae (Vanhöffen, 1902a; Bigelow, 1909), was soon shown to be a trachynemid (Bigelow, 1913). But it is not yet possible to give any precise generic definition for it that can be depended upon to stand the test of time. During the first years of its history it was, indeed, regarded as a very sharply defined genus, for while the type species (*C. brunnea* Vanhöffen) agrees with *Aglaura* and *Aglantha* in the structure of the gonads, it differs markedly from them not only in lacking any trace of a gelatinous peduncle, but also—and from all other Trachynemidae as well—in having more than one row of tentacles. Shortly, however, other species were described, one of which (*rufobrunnea*, Kramp, 1913) apparently had the tentacles in a single row,[8] while in another (*C.*

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[7] Thiel's (1936) chart of distribution for *Pantachogon* also includes the *Colobonema* records, for he classes the latter as a synonym of the former.
[8] Broch (1929, p. 506) says "Ersichtlich in einer Reihe."

pedunculata Bigelow, 1913), there is a short gelatinous peduncle. The former partially bridges the gap between *Crossota* and *Pantachogon,* the latter between *Crossota* and *Aglantha,* i.e., between the subfamilies Rhopaloneminae and Aglaurinae, as defined by Broch (1929) and by Thiel (1936, p. 9). Indeed, *pedunculata* is tentatively referred to *Aglantha* by Thiel (1936, p. 22). But this course would involve expanding that genus to include species with tentacles in more than one series, for in *C. pedunculata* these are in three or four irregular rows, much as in *Crossota brunnea.* Until Kramp and Damas' (1925, p. 317) characterization of the tentacles of *norvegica* as being in a single row is confirmed, it seems simplest to confine *Crossota* to Trachynemidae with sausage-shaped gonads hanging free from the subumbrella and with many closely crowded tentacles, in more than one row, irrespective of whether or not there is a short peduncle. Data as to the number of otocysts is much to be desired. In the only species in which any estimate of this has been possible, they have proved much more numerous than they are in *Aglantha.*

? **Crossota brunnea** Vanhöffen.

Crossota brunnea, Vanhöffen, 1902a, p. 73, Pl. 9, Figs. 11-13, Pl. 12, Figs. 34-38, 43-47; Bigelow, 1909, p. 135, Pl. 2, Fig. 7, Pl. 45, Fig. 9; Mayer, 1910, p. 396.

Crossota brunnea [Partim], Thiel, 1936, p. 20[9].

Crossota brunnea, var. *norvegica,* Bigelow, 1913, p. 48.

Crossota norvegica, Broch, 1929, p. 5Q7.

? *Crossota norvegica,* Kramp, 1920, p. 5.

Non *Crossota norvegica,* Vanhöffen, 1902a, p. 75; Kramp and Damas, 1925, p. 317.

See Thiel (1936, p. 21) for a recent summary of the checkered history of *C. norvegica* Vanhöffen and for the reasons why *norvegica* cannot be used as the name for a variety of *C. brunnea* as I formerly did (Bigelow, 1913).

Material: Net Nos. 241, 642, 665, 733, 787, 794, 854, 869; 1,097-0 to 1,829-0 meters; 11 very fragmentary specimens, all approximately 14 mm. in diameter.

These specimens are all in such poor condition that identification is only tentative; in every case all trace of the manubrium and gonads has been lost and only faint indications of the radial canals are to be seen. At first sight, it seemed that they might belong to *C. rufobrunnea* Kramp, for in most cases the tentacular bases—in their present state—have the appearance of being in a single row. But in one specimen in which the margin is in somewhat better condition than in the others, the larger (older) tentacle-bases arise at a slightly higher level than do the smaller (younger) ones, for which reason it seems more probable that the whole series belongs to *C. brunnea.* In some parts of the margin, 3 successive sizes—or rows—of tentacles can be recognized, in others only two, as was the case in the *Meteor* specimen recently described by Thiel (1936, p. 20). In the specimens of *brunnea* that I have seen, in good enough condition to show the tentacles (Bigelow, 1909; 1913), the arrangement in different rows has been less regular than Vanhöffen (1902a, Pl. 12, Fig. 47) pictured it, the tentacles being more crowded and the older only a very short distance above the younger, instead of well above the latter: this distribution is more correctly represented in Vanhöffen's 1902a, Pl. 12, Fig. 46) section of the margin.

[9] Thiel (1936) includes *C. alba* Bigelow in the synonymy of *C. brunnea.*

It was not possible to make a reliable count of the tentacles, even in any one octant, owing to the uncertainty as to the precise location of the radial canals. In the specimen just mentioned, the spacings of the tentacular-bases suggests a total of at least 200. No otocysts were to be found.

In most of the specimens enough of the subumbral pigmentation is still intact to show that it was of the characteristic opacity and chocolate or reddish brown color.

General Distribution: Previous records probably referable to *C. brunnea*, as mapped by Thiel (1936, p. 23), are widely scattered in the eastern side of the Atlantic from Latitude about 50° N. down to the Antarctic—extended, now in all probability to the western half of the Sargasso Sea—; in both sides of the Indian Ocean; and in the parts of the eastern tropical and far northern Pacific traversed by the *Albatross* on the cruises of 1904-1905 and 1906. It has not been taken, however, in the Mediterranean. And while reaching high latitudes in the south, it apparently does not inhabit the North Polar regions.

Vertical Range: All captures have been in deep hauls.

? **Crossota.**

The following fragments (now mere shells) are tentatively referred to *Crossota* because such indications of the locations of the tentacles as are still to be seen suggest that these were numerous and close crowded, and because most of the specimens still show some trace of subumbral pigment. But specific identification is out of the question.

Net Nos. 41, 66, 74, 75, 101, 114, 137, 138, 220, 295, 640, 644, 647, 666, 724, 748, 770, 779, 807, 812, 815, 844, 849, 867, 885, 891, 917, 935, 959, 967, 970; 914-0 to 1,830-0 meters; fragments of 37 specimens.

TRACHYNEMIDAE gen. ?

Medusae, apparently belonging to the Trachynemidae, but in such poor condition as to preclude even provisional identification, were taken in Net Nos. 110, 145, 269, 295, 317, 322, 327, 341, 449, 574, 577, 598, 613, 644, 680, 715, 718, 726, 738, 767, 785, 795, 799, 807, 824, 827, 867, 882, 885, 896, 926, 968; a total of 51 specimens, 1-4 per haul.

HALICREIDAE.

Halicreas.

Opinions have differed whether such of the Halicreidae as have only 8 canals, and tentacles in a continuous row (i.e., not grouped as they are in *Botrynema*) should all be referred to the one genus, *Halicreas*, or to two genera; and if the latter, whether generic separation should be based on number of tentacles alone, as by Vanhöffen (1902a), on this character combined with the form of the umbrella, as by Ranson (1936); or on the presence or absence of exumbral papillae, as formerly by me (1909).

Even granting eventual agreement as to the relative taxonomic value of different characters, we still face a nomenclatural difficulty (if two genera are to be recognized), in the fact that the decision as to the correct name of the second genus would depend on the true identity of the specimen originally described by Maas (1893) as *Homoeonema platygonon*, and later declared by him (Maas, 1906, p. 3) to be a halicreasid, not a trachynemid as he originally supposed.

Examination of the type specimen of *H. platygonon,* if this be still in existence, would settle the point. Meanwhile it seems simplest to follow Broch (1929) and Thiel (1936), in uniting, in *Halicreas*, all halicreasids

with 8 canals and continuous series of tentacles, whether the exumbrella be papillate or smooth, and whether the tentacles be few or numerous, all of one size, or of two sizes. For further discussion, see Ranson (1936) and Thiel (1936).

Among the named forms referable to *Halicreas* as thus expanded, two (*H. minimum* Fewkes and *H. papillosum* Vanhöffen) are set apart by the presence of exumbral papillae. Thiel (1936), it is true, bases the specific distinction within *Halicreas* solely on whether the tentacles are of one size or of two sizes. I see no reason, however, for abandoning the presence or absence of exumbral papillae as of specific value here, even if it be not of generic worth as I formerly suggested; not only are these structures highly distinctive features, but no variation has ever been found in their number. And Ranson (1936) also considers them as specific.

H. papillosum is the best-known member of the genus, and large series of it have been taken on most of the recent expeditions that have done deep towing. It has, however, long been generally recognized that it might eventually prove to be identical with the *H. minimum* of Fewkes (type species of the genus) which was described 20 years the earlier, consequently *minimum* has repeatedly been classed as a doubtful synonym of *papillosum* in the lists of references to the latter. Fortunately, the collection of the Museum of Comparative Zoology contains one of Fewkes' original two specimens (previously overlooked) ; evidently the one described by him (1882, p. 306) as "expanded" and "preserved in spirit." Although this specimen has subsequently been dessicated, then restored to alcohol, the typical exumbral papillae (each with several conical projections) are still to be seen, while the locations of the 8 radial canals are marked as broad, flat ridges on the subumbrella. And fragments of the circular lip are still recognizable. What Fewkes took for the velum was in reality the marginal zone of the bell, distal to the exumbral papillae. Thus, while the tentacles have all been lost —as indeed Fewkes pointed out—there is no reason to doubt that it is the same species that Vanhöffen (1902a) later described as *papillosum*, while Fewkes' specimens were from a locality where many *papillosum* have since been taken, on the cruises of the Woods Hole Oceanographic Institution. Consequently, there need no longer be any hesitancy in superseding *papillosum* by *minimum*, thus making one more step toward stability in the nomenclature of the medusae.

It has long been obvious that the five named representatives of the smooth-belled subdivision of the genus (*conicum*, *album*, *glabrum* and *rotundatum* Vanhöffen, 1902a; *recovitzae* Maas, 1906) stand in need of drastic reduction, successive studies (Bigelow, 1909; Ranson, 1936) having proved that the features on which Vanhöffen (1902a) laid chief stress (degree of doming of the exumbrella, and precise location of the gonads on the radial canals), are too variable to be of taxonomic significance. Thiel's (1936) recent grouping, based on whether there are two sizes of tentacles or only one, is a decided advance. It is certain that the tentacles are all alike in *racovitzae*, for Maas (1906) definitely states as much; likewise in *conicum* (Vanhöffen, 1902a, Pl. 11, Fig. 33). On the other hand, it seems equally certain that the original specimens of *glabrum* had tentacles of two sizes, because Vanhöffen (1902a, p. 70) describes them as "ebenso wie bei *H. papillosum* angeordnet." Hence—as *glabrum* has page priority in Vanhöffen's original paper—this name may be accepted for smooth-belled *Halicreas* with 2 sizes of tentacles.

Unfortunately, Vanhöffen gave no definite information on this point, either for his *Halicreas album* or his *Halicreas rotundatum*. The first of these is placed by Thiel (1936) in the group in which the tentacles are all of one size (i.e., grouped with *racovitzae* and *conicum*). And the original accounts certainly would allow this interpretation. But Vanhöffen's (1902a, p. 68) statement that "so wohl *Halicreas* wie *Haliscera*" has tentacles of

two sizes, makes it seem more likely that this was true of his specimens of *album* and *rotundatum*. Hence it seems justifiable to class these names provisionally as synonyms of *glabrum*, recognizing, however, that the wide variation in numbers of tentacles between the several forms may finally warrant a further subdivision on this basis.

Halicreas minimum Fewkes.

Halicreas minimum, Fewkes, 1882, p. 306.

Halicreas papillosum, Vanhöffen, 1902a, p. 68, Pl. 9, Figs. 7-8; Pl. 11, Fig. 30.

For the more important subsequent references, see *Halicreas papillosum*, Mayer, 1910, p. 391; Ranson, 1936, p. 164; *Halicreas papillosum* [Partim], Thiel, 1936, p. 34.

Material: Net Nos. 25, 26, 41, 43, 44, 56, 60, 62, 65, 66, 67, 68, 69, 75, 76, 81, 83, 108, 110, 115, 124, 138, 144, 157, 203, 241, 247, 269, 270, 271, 293, 295, 297, 357, 360, 383, 401, 405, 406, 442, 466, 468, 481, 488, 501, 566, 569, 570, 576, 590, 599, 640, 648, 654, 682, 683, 684, 701, 703, 717, 718, 722, 723, 724, 727, 728, 730, 736, 741, 746, 750, 751, 756, 765, 767, 774, 781, 787, 788, 795, 799, 815, 852, 857, 858, 863, 864, 869, 875, 887, 893, 898, 919, 931, 932, 933, 935, 940, 942, 947, 963, 969, 970; at depths ranging from 0 to 2,012-0 meters; a total of 186 specimens; 1-6 specimens per haul, except for one catch of 17 specimens in Net No. 271.

The specimens, ranging from about 13 mm. to about 36 mm. in diameter, are all fragmentary, having lost every trace of marginal organs and of the gastrovascular system. Hence, they add nothing to previous accounts of the morphology of this interesting bathypelagic medusa. This species is, however, made so easily recognizable by the marginal papillae—structures so resistant that they persist even after the roughest handling—that identity seems assured. Most of them also show more or less trace of the gelatinous apical projection, though the discs of others are apically rounded, in their present condition.

General Distribution: Earlier records of capture are widespread over the eastern side of the tropical Pacific, also the tropical and subantarctic belts of the Indian Ocean, the East Indies and Philippines, Japan, Sea of Okhotsk, Bering Sea, the South Atlantic down to the Antarctic, north boreal and east temperate belts of the North Atlantic (Thiel, 1935, Fig 38; 1936, p. 36, Fig. 7; Ranson, 1936). It had been taken on the continental slope of America in the offing of Woods Hole. Curiously, however, there was no previous record of it in the Sargasso Sea region. The Bermuda records, proving it abundant there, are therefore interesting as cumulative evidence that it is cosmopolitan in the ocean basins at suitable depths, at low and mid-latitudes.

However, it has not been taken in the Mediterranean, in spite of the great number and wide distribution of deep hauls that have been made there by the *Thor* and by the Prince of Monaco (Kramp, 1924; Ranson, 1936). And its absence, or at least rarity, there is puzzling, for the comparative frequency of records from small depths at low latitudes in the Atlantic (see below), makes it unlikely that the shoalness of the sill depth of the Straits of Gibraltar can offer a permanent barrier to its entrance into the Mediterranean, as it apparently does in the case of certain more strictly bathypelagic animals (Bigelow and Sears, 1937, p. 128). For further discussion of its distribution and dispersal in the South Atlantic, see Thiel, 1935, p. 72.

Seasonal Distribution: The seasonal distribution of the hauls yielding *H. minima*, for the two years combined, appear from the following tabulation:

Month.	Hauls Yielding *H. minimum.*	Total Hauls, 1,280-0 Meters or Deeper.	% Yielding *H. minimum.*
April.	6	20	30
May.	24	77	31
June.	22	135	16
July.	17	109	15
August.	5	40	12
September.	29	158	19

This shows a somewhat greater abundance in spring, for the two collecting seasons combined, than during the summer months.

Vertical Range: The early records were all from hauls with open nets, leaving in doubt the precise depths from which the specimens came, but the great majority of the catches were from hauls that sampled down to 500 meters or deeper. Thus, the shoalest of the 40 *Valdivia* hauls that yielded specimens positively identified as *H. minimum* was from 600-0 meters, 37 of them at least 1,000-0 meters[10] or deeper (Vanhöffen, 1902). All of the 30 *Albatross* catches were, similarly, in hauls from 550-0 meters (Bigelow, 1909; 1913; 1919), while the records of the Prince of Monaco were all from 1,000-0 meters or deeper (Ranson, 1936).

The *Meteor* records have shown, however, that *H. minimum* is not exclusively restricted to great depths, but may populate the whole column from, say, 75 meters down to 800-900 meters, as appears from the distribution of catches in closing nets, tabulated below, from data presented by Thiel (1935, Tables 10, 21, Fig. 27; 1936, p. 34):

Depth in Meters.	Number of Cases.	Number of Specimens.
50- 70	1	1
50-100	7	8
100-200	2	2
200-400	5	7
400-600	4	5
600-800	2	1

And still more recent captures by *Atlantis* of the Woods Hole Oceanographic Institution make it unlikely that there is any definite lower boundary to its occurrence, any more than for various siphonophores (Bigelow and Sears, 1937, p. 137), for horizontal closing net hauls of uniform duration at 3 stations as described by Leavitt (1935) in the summer of 1935, yielded the following catches:

Depth in Meters.	Number of Cases.	Number of Specimens.
600	1	6
1,200	1	4
1,800	1	3
2,000	1	2
2,200	2	2

[10] One juvenile, perhaps of this identity, was taken at 200-0 meters.

The Bermuda collection amplifies the foregoing, proving that *H. minimum* may occasionally come right up to the surface (Net No. 654, 1 specimen). But in this part of the Sargasso Sea, where the thickness of the superficial stratum of warm water is great, the chief center of abundance lies deeper than in most parts of the oceans, or at least as deep as 1,400-1,800 meters, as appears from the following tabulation for the two seasons combined:

Depth in Meters.	No. of Hauls with *minimum*.	Total Number Hauls.	% with *minimum*.
732-0	2	40	5
913-0	3	132	2
1,097-0	2	134	2
1,280-0	8	132	6
1,463-0	21	132	15
1,646-0	34	135	25
1,829-0	31	135	22
2,012-0	3	4	45

H. minimum (seemingly also *H. glabrum* and *Halitrephes*) thus is a marked exception to the general rule that medusae having their center of abundance so deep, are densely pigmented.

Thiel (1935, p. 47) has shown, from the catches made in closing nets by the *Meteor,* that the individuals of the genus *Halicreas,* as a whole, average larger, the greater the depth. This suggests that the young stages are passed chiefly in the shoaler strata and that the medusae tend to sink as they grow larger. But we still await positive evidence whether the eggs, as a whole, rise to the surface, as he suggests (Thiel, 1935, p. 72).

? *Halicreas glabrum* Vanhöffen.

Halicreas glabrum, Vanhöffen, 1902a, p. 70, Pl. 9, Fig. 3; Mayer, 1910, p. 392; Ranson, 1936, p. 167.

Homoeonema glabrum, Bigelow and Leslie, 1930, p. 564.

Haliscera alba, Vanhöffen, 1902a, p. 71, Pl. 9, Fig. 5.

Homoeonema alba, Bigelow, 1909, p. 142, Pl. 3, Fig. 1-2, Pl. 33, Figs. 6, 11, Pl. 34, Fig. 9.

Halicreas album [Partim], Thiel, 1935, p. 48; 1936, p. 37.

Halicreas rotundatum, Vanhöffen, 1902a, p. 71, Pl. 9, Fig. 4; Maas, 1905, p. 57; Mayer, 1910, p. 392.

Halicreas papillosum [Partim], Thiel, 1936, p. 34. [Non *H. papillosum,* Vanhöffen, 1902.]

Material: Net Nos. 25, 43, 56, 62, 68, 75, 83, 89, 106, 114, 144, 145, 157, 218, 242, 247, 269, 270, 271, 295, 297, 315, 339, 345, 346, 347, 354, 359, 449, 466, 488, 501, 506, 539, 710, 742, 890, 942, 962; hauls from 914-0 meters to 2,012-0 meters; 66 specimens, 1-5 per haul.

These specimens—like Ranson's—agree very closely with Vanhöffen's (1902, p. 9, Fig. 3) illustration of *H. album* in the form of the bell, with high conical apex, and thin marginal zone, without any sign of the exumbral protuberances. But as already suggested (Bigelow and Leslie, 1930, p. 564), and as indicated above (p. 122), it is probable that *album* is specifically identical with Vanhöffen's *H. glabrum* and the latter name has page priority.

In every case, all trace of all the tentacles has been lost, preventing posi-
tive identification; in fact the great majority are mere shells. But in a few,
parts of the subumbrella still remain. And one from Net No. 890, another
from Net No. 942, are especially interesting, being in good enough condi-
tion to show the oval gonads situated proximally, leaving the distal parts of
the radial canals free, as was the case in the *Albatross* specimens (Bigelow,
1909). And this corroborates Ranson's (1936, p. 168) observation that in
his specimens (which had lost the gonads) the traces of the radial canals
suggested proximal enlargements.

General Distribution: Previous records positively referable to *glabrum*
+ *album* are from the vicinity of the Azores (Ranson, 1936); and scattered
along the route of the *Valdivia* in the eastern side of the Atlantic, from the
offing of Morocco to Lat. 42° S., besides one locality record for the southern
Indian Ocean (Vanhöffen, 1902a); several in the eastern tropical Pacific
(Bigelow, 1909)[11]; and off California (Bigelow and Leslie, 1930). With the
Bermuda records extending its known range to the western side of the
North Atlantic, there seems no reason to doubt that the distribution of *H.
glabrum* will eventually prove to be as wide as that of its better known
relative, *H. minimum* (p. 122).

Vertical Range: It is not yet possible to make a final statement as to the
vertical distribution of *H. glabrum*, as here defined, because it is combined
with *H. racovitzae* and *H. conicum* in Thiel's (1935, 1936) discussions of
the *Meteor* closing-net data. However, the fact that the *Valdivia, Albatross*,
and Bermudian specimens all came from (open net) hauls from 550-0
meters, or deeper, suggests that it is chiefly bathypelagic in habit, though
perhaps not exclusively so.

Halitrephes.

This genus, closely allied to *Halicreas* by the structure of the tentacles
and of the sense organs, as well as by the simple circular mouth, without
separate lips, but separated from it by the large number of radial canals,
was first described from the collection made by the *Albatross* in the eastern
tropical Pacific as *H. maasi* (Bigelow, 1909, p. 146, Pl. 33, Figs. 1-5, 7, 10,
Pl. 45, Fig. 13). In the type specimen of the latter, 55 mm. in diameter, 28
canals were given off from the stomach, 5 of them branching dichotomously
so that the number at the bell margin was 33; and there were about 70
tentacles of different sizes. Three years later, Vanhöffen (1912) described
a second species, as *H. valdiviae*, from the collection of the German South
Polar Expedition, with as many tentacles or even more, but separated from
maasi by having only 16 canals. As the specimens examined by him
ranged in diameter from 18 to 70 mm.—i.e., included full grown individuals
as well as juveniles—the specific distinction seems well founded.

As the genus has not been seen since, the captures listed below from
Bermuda are of interest, for although the specimens are extremely frag-
mentary, their identity seems reasonably certain.

Halitrephes valdiviae Vanhöffen.

Halitrephes valdiviae, Vanhöffen, 1912, p. 384.

Material: Net Nos. 135, 154, 247, 357, 451, 562, 580, 614, 635, 709,
714, 745, 767, 778, 818, 830, 843, 967; hauls from 914-0 to 1,829-0 meters;
19 specimens about 30 to 80 mm. in diameter.

All the specimens are in poor condition. Even when much battered,

[11] Thiel's (1936, p. 36) chart of distribution also includes locality records for *racovitzae* and
conicum.

however, the flat, lenticular form, but with central thickening, combined with numerous endodermal tentacular roots, (which are so resistant that they are recognizable even in the most fragmentary specimens), give a general aspect so characteristic as to make *Halitrephes* easily recognizable, even when the canals have been lost. And the two known species differ so widely in the number of tentacles that in most cases a specimen is referable either to the one or to the other, with reasonable certainty. All of the Bermudian specimens show the endodermal roots of some of the tentacles; and in one example, several tentacles are still sufficiently intact to show the contrast between stiff distal, and soft proximal, portions, characteristic of the Halicreidae. It was not possible to make certain of the total number of tentacles, in any specimen. But the minimum number (specimen of about 55 mm.) was certainly as great as 102. In another of 45 mm., there were at least 105, while in others of 60-80 mm., 145-170 tentacular roots were counted, total numbers being evidently somewhat greater. This corresponds well to the distribution with size recorded by Vanhöffen (1912) of 32 tentacles in a specimen of 12 mm.; 32-64 tentacles at a diameter of 18-20 mm.; 64-96 at a diameter of 30-40 mm.; and 200 at 70 mm. As pointed out for *H. maasi* (Bigelow, 1909, p. 146), the tentacular bases are of various sizes, indicating their successive development. But as no trace of canals is to be seen in the marginal zone of any of the Bermudian specimens, nothing can be said as to the order of development of tentacles relative to canals.

In one specimen, a sector of the margin still bears several rhopalia, alternating with the tentacular roots, as is the case in *H. maasi,* and agreeing closely with the rhopalia of the latter in structure and club-like appearance (Bigelow, 1909, Pl. 33, Fig. 10). The only example in which there is any trace of the gastrovascular system still to be seen, shows the circular lip characteristic of the genus and its allies, with the bases of about 8, at, broad canals in about one-half the circumference, suggesting a total of about sixteen; or the same number described by Vanhöffen (1912) for the original series of *H. valdiviae.*

General Distribution: The original collections of *H. valdiviae* were from the tropical Atlantic between Lat. 6° N. and Lat. 20° S.; and from the Indian Ocean between Lat. 2° N. and Lat. 34° S. The Bermuda captures are thus the most northerly yet recorded, and the farthest extra-tropical for the Atlantic. Present indications are that this is a tropical and subtropical species, else it would probably have been picked up in some of the many deep towings that have been made farther north and east in the Atlantic.

Vertical Range: All the records for *H. valdiviae* have so far been from hauls that worked down to at least 500 meters; in most cases to at least 1,000 meters. Its bathypelagic status thus seems established.

More precise information as to the depth of its chief center of abundance would be of interest, because, while colorless, most of the captures, like those of *Halicreas minimum,* have been in nets working so deep as to indicate that the specimens were from levels inhabited also by the deeply pigmented groups of medusae, and by the black bathypelagic fishes.

GERYONIDAE.

Liriope.

Although this sharply defined genus is perhaps the most often encountered of Trachomedusae, there has been no agreement as to the specific relationships of its many described representatives, owing to the difficulty (I believe we may say "impossibility") of finding any differences, the gaps between which cannot be bridged by examination of sufficiently large series. Final decision that all known representatives of *Liriope* represent but a

single variable species was already foreshadowed in Browne's (1927) interesting exposition of the situation that faces every student of the genus. Thiel (1936, p. 45) has now definitely made this union of all the named forms under the oldest designation, *L. tetraphylla* Chamisso and Eysenhardt. And the reader is referred to his discussion for a clear exposition of the reasons justifying this procedure. Granting, however, that the various forms of *Liriope* cannot be considered "species," in the sense in which the term is generally employed in zoological nomenclature, it still remains an interesting question how they are to be interpreted, and how recorded in scientific literature. While it is now established that intergrades can be found with regard to every character which has been suggested as specific, we have still to recognize that the representatives of different swarms, or of different populations (seasonal or regional), often do differ so widely in many respects, as Browne (1927) has vividly described, that they would be referred without hesitation to different species had not the existence of intermediates been proved.

Liriope tetraphylla Chamisso and Eysenhardt.

Geryonia tetraphylla, Chamisso and Eysenhardt, 1821, p. 357, Pl. 27, Fig. 2.

For lists of references to the named forms of *Liriope*, all of which, following Thiel (1936) are now referred to *L. tetraphylla*, see Mayer, 1910, p. 413-424; also, Thiel, 1936, p. 45.

Material: Net No. 51, Surface, April 29, 1929, 1 specimen about 5 mm. in diameter.

The gonads in this young specimen are of about the same form as in a 7 mm. specimen, already pictured from the eastern tropical Pacific (Bigelow, 1909, Pl. 4, Fig. 3), namely, squarish with rounded angles. This stage has already been proved preliminary to the triangular or rhomboid outlines often, but not always, attained by adult *L. tetraphylla*.

The most interesting thing about this record is that 974 hauls in various months from May to October, in two different years, yielded only the one specimen of a genus so widespread and frequently abundant in warm seas. Nor can the paucity be credited to the depths at which the hauls were made, for 108 of them were in the upper 200 meters; 86 right at the surface. This, added to the corresponding fact that the *Bache* hauls in the winter of 1914, yielded only 4 *Liriope* at 2 stations on lines run between Cape Hatteras, Bermuda, the Bahamas, and the Straits of Florida, can only mean that it was decidedly rare in this side of the Sargasso Sea area during the periods in question, which included both the warm and the cold months. This is the more astonishing, when one remembers that the Plankton Expedition (Maas, 1893) took *Liriope* regularly from Latitude about 40° N., southward to Bermuda; and thence eastward all along the track across the tropical Atlantic.

Geryonia.

Geryonia proboscidalis Forskål.

Medusa proboscidalis, Forskål, 1775, p. 108.

For synonymy, see Bigelow, 1909, p. 116, and Mayer, 1910, p. 425.

Material: Net No. 613, 1,097-0 meters, 1 fragmentary specimen, diameter about 30 mm.

Net No. 621, 1,097-0 meters, 1 fragmentary specimen, diameter about 16 mm.

Net No. 850, 1,463-0 meters, 1 fragmentary specimen, diameter about, 25 mm.

These very fragmentary specimens (identified by the number of canals) add nothing to previous knowledge of the morphology of this well known species.

Geryonia had already been reported to the north and to the east of Bermuda (Maas, 1893) as well as at many other localities in the warm belt of the Atlantic.

NARCOMEDUSAE.

In the classification adopted by Broch (1929), by Ranson (1936), by Uchida (1928), and by me in earlier papers (Bigelow, 1909; 1913; 1918; 1919), the Narcomedusae that have gastric pockets are divided into two families, Cuninidae and Aeginidae, depending on whether the pockets are perradial, equal in number to the tentacles, and not extending out beyond the points of origin of the latter (Cuninidae), or whether the definitive pockets are interradial in location, and at least twice as numerous as the tentacles, with the tentacles arising in the notches between the pockets (Aeginidae). This scheme is followed here. Thiel (1936, p. 55), on the contrary, follows Mayer (1910), in referring all Narcomedusae with peripheral gastric pockets to one family, Aeginidae.

Such of the typical Narcomedusae as lack gastric pockets are now generally grouped in the family Solmaridae. If the curious sand-dwelling form, *Halammohydra*, actually is an aberrant Narcomedusa, as Remane (1927), Uchida (1928), and Leloup (1935) believe, it calls for a separate family (Halammohydriidae, Remane).

Cunina.

Cunina sp.?

Material: Net No. 242, 1,646-0 meters, 1 specimen, about 30 mm. in diameter.

Although this specimen is very much damaged, enough remains to show that it had perradial gastric pockets, and a well developed peronial canal system, a combination of characters locating it in the genus *Cunina*, as contrasted with *Solmissus*, which lacks canals. Unfortunately, the exumbrella is so much rubbed or macerated, that it is impossible to tell whether, or not, otoporpae were present. And all the otocysts have been destroyed. There are 23 large tentacles and one very small one. Identification of any specimen of *Cunina* with as many as 20 tentacles depends, in the first place, on decision whether the *Medusa mucilaginosa* of Chamisso and Eysenhardt (1821), with 21-24 tentacles, belonged to *Cunina*, to which Blainville (1834) referred it, or whether it actually was a *Solmissus* according to the definitions for these two genera now generally adopted. The name *mucilaginosa* was used by Vanhöffen (1908a, as "*Solmaris mucilaginosa*") for a series of Cuninidae of large size (25-60 mm. in diameter), with 21-24 tentacles. But since his specimens lacked peronial canals (he gave no information as to the presence or absence of otoporpae), they are more likely to have belonged to *Solmissus* than to *Cunina*.[12] And I have argued (Bigelow, 1909, p. 55; 1918, p. 392) that it was wisest to discard *mucilaginosa* as a nomen nudem, because it will never be possible to tell from Chamisso and Eysenhardt's account, to which of these two genera their original specimens did actually belong, lacking information on the critical points—canals and otoporpae. Ranson (1936, p. 200), however, has recently revived this name, for a *Cunina* of 55 mm. with 21 tentacles.

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[12] See Bigelow, 1919, p. 327, for discussion of Vanhöffen's treatment of the genus *Solmissus*.

Without attempting to settle this question, I may point out that if *mucilaginosa* be finally accepted as a *Cunina*, it was the earliest named member of this genus. Hence, if it lies within the varietal range of the species commonly called *rubiginosa,* a possibility suggested by Thiel (1936), *mucilaginosa* must take precedence over *rubiginosa,* and the latter becomes a synonym of it.

Solmissus.

? **Solmissus incisa** Fewkes.

Solmissus incisa, Fewkes, 1886, p. 954, Pl. 9; Bigelow, 1909, p. 67, Pl. 21, Figs. 1-3, 5; 1913, p. 57; Mayer, 1910, p. 483; Broch, 1929, p. 527; Uchida, 1928, p. 90; Bigelow and Leslie, 1930, p. 560; Ranson, 1936, p. 206.

Solmissus faberi, Haeckel, 1879, p. 350.

Solmissus bleekii, Haeckel, 1879, p. 351.

? *Solmaris rhodoloma,* Vanhöffen, 1908a, p. 60, Pl. 1, Fig. 5. [non *Aequorea rhodoloma* Brandt, 1838.]

Material: Net Nos. 599, 628, 632, 680, 700, 713, 735, 753, 765, 799, 848 885, 891; 914-0 to 1,829-0 meters; 13 specimens; those of which measurement is possible, range from about 50 mm. to about 75 mm. in diameter; also other fragments.

These specimens — all extremely fragmentary — are identifiable as *Solmissus* because they show indications of the presence of gastric pockets in the radii of the tentacles, but no signs of a canal system. In all cases, the free gastric wall has been destroyed, but persistant bands of subumbral tissue, around the outer margins of the pockets, and in the septal spaces between them, show the pockets to have been oval in outline and somewhat longer than broad. This fact, combined with the large number of tentacles (see below), warrant tentative reference to *S. incisa.* And this identification is rendered the more probable by the fact that even in their present state, they agree in thinness of the disc, in softness of the gelatinous substance, and generally in appearance, with the *incisa* collected by the *Albatross* in the Pacific, with which I have been able to compare them.

In no case was an exact count of the tentacles possible, but the presence of at least 23 in one specimen of about 55 mm., and of 25 to 30, in three others of, roughly, 60 and 75 mm., corresponds with earlier counts, which have shown a range of from 23-40 in specimens 50 mm. in diameter or larger. This contrasts with a maximum of 16 tentacles in *S. albescens* and in *S. marshalli.*

All specimens of *S. incisa* previously seen have lost all trace of the gonads, nor is the present series any better in this respect. They do, however, confirm Fewkes' original illustration of the marginal outline as straight or nearly so, from peronium to peronium. All the otocysts have been lost, and even the pads on which these organs stand.

General Distribution: *S. incisa* was to be expected in the vicinity of Bermuda, for it has been taken at several stations along the American continental slope, between the latitudes of Cape Hatteras and of Sable Island, Nova Scotia, on the one side, and mid-way between Bermuda and the Azores on the other. Other Atlantic records are off the coasts of France and of Spain. It has also been taken at a number of localities in the eastern tropical Pacific; off Monterey, California; between San Francisco and the Aleutians; in the Bering Sea region; off Kamchatka; and in Japanese waters.

Vertical Range: Most of the captures of this species have been from hauls made with open nets at considerable depths, but the list includes three captures from the surface, one from the northwestern Atlantic (Fewkes, 1886), the others from the eastern tropical Pacific (Bigelow, 1909).

AEGINIDAE.

Aegina.

Up to 1910, fourteen supposed "species" referable to *Aegina* had been described. Mayer's (1910) summary made it clear, however, that this list required drastic reduction. And as the result of subsequent studies, by various authors, evidence has gradually accumulated to the effect that all Aeginas yet described represent at most two species, the *Ae. rosea* and *Ae. citrea* of Eschscholtz (Bigelow, 1913; 1919; Broch, 1929; Ranson, 1936); or perhaps only one as Thiel (1936) has most recently argued. Decision here rests on whether the difference between the *"citrea"* type, in which the margin of each of the eight adradial gastric pockets is more or less indented in the mid-line, and the *"rosea"* type in which it is entire, is genetic, or is simply the result of sex or of age differences, of differing degrees of distention of the pockets, or of contraction, as Thiel (1936) maintains. The situation may be summarized as follows (see Thiel, 1936, p. 74, for details): Juveniles, up to perhaps 9 mm. in diameter, have undivided pockets, i. e., are, as a rule, of the *"rosea"* type; all very large specimens (35 mm. in diameter or larger), so far recorded, (of which adequate descriptions were given) have likewise been of the *"rosea"* type;[13] for example, Haeckel's (1879) *Ae. rhodina*, and the *rosea* reported by me (1913) from the northwest Pacific. Among middle-sized individuals, however, of, say, 9-25 mm. in diameter, both types have been recorded. Otherwise stated, all typical *citrea* have fallen within this size range, whereas the much more numerous records of the *rosea* type have covered the entire size range so far recorded for the genus. Furthermore, several specimens of 7-16 mm. in the present series show intermediate conditions, with some of the adradial pockets notched, others not, or showing a slightly sinous outline. One point not previously stressed is that in specimens of the *citrea* type the gonads usually (but not always) form two swellings on the oral surface of each primarily adradial pocket, whereas in the *rosea* type, the swelling involves the oral surface of each of the 8 pockets as a whole. In oral view, that is to say, there are up to 16 very conspicuous swollen areas (sometimes only 14 or 15) in the *citrea* type, but only 8 in the *rosea* type. And this difference is much more conspicuous than is the difference in outline of the pockets, for even at its maximum, the latter is slight.

The question as to the relationship of the two types cannot be settled until a microscopic study is made to determine whether we may not be dealing here with a sexual dimorphism—nor would this be unique among Narcomedusae, for the gonads of the two sexes of *Aeginura* differ widely, in appearance. But the present series does not offer hopeful material for histological study. It is also possible that the very large representatives of the *rosea* type are spent individuals. Nor can the rôle played in this matter by contraction be determined without a study of living material.

Meantime it seems wisest to follow Thiel, at least provisionally, and to class *citrea* and *rosea* as forms (of undetermined significance) of one species. This, however, must be named *citrea*, not *rosea* as Thiel has called it, because the former has page priority in Eschscholtz's (1829) original accounts of the two.

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[13] *Ae. alternans* (Bigelow, 1909) was probably a large damaged *rosea* (Bigelow, 1913, p. 59).

Aegina citrea Eschscholtz.

Aegina citrea, Eschscholtz, 1829, p. 113, Pl. 10, Fig. 3.

It is probable, as explained above, that all the citations to supposed species of *Aegina,* listed by Mayer, 1910, p. 451-454, refer to one variety or another of this species. For a recent list of references, see Thiel, 1936, p. 73 (*"Ae. rosea"*).

Material: Net Nos. 263, 292, 294, 296, 488, 564, 566, 576, 627, 649, 657, 666, 686, 692, 693, 708, 745, 762, 779, 800, 809, 857, 874, 882, 885, 971; hauls from 0 to 1,829-0 meters; 31 specimens, 5-20 mm. in diameter, in various stages of preservation.

Among the specimens that are well enough preserved to show the gastric pockets, 9 (ranging in diameter from 5-20 mm.) are definitely of the *rosea* type, i.e., the adradial pockets show no signs of additional subdivision. Two, of 15-16 mm., are as definitely of the *citrea* type. The most interesting specimens are nine others (7-16 mm. in diameter) which show various intermediate states as follows:

A. Each adradial pocket shows but one swelling (*"rosea"* type); margins of some pockets entire (*"rosea"* type), of others notched (*"citrea"* type).

B. Some pockets show *"citrea"* swellings, some *"rosea"*; margins of all pockets entire (*"rosea"* type).

C. Swellings as above; margins of some pockets notched (*"citrea"* type), of others entire (*"rosea"* type).

D. Each pocket with 2 swellings (*"citrea"*); but with margin entire (*"rosea"*).

Obviously, these corroborate Thiel's (1936) view that it is not possible to segregate two groups (however named) on this basis. However, we are still faced with the fact that while a great majority of specimens of the *"citrea"* type show the normal metamerism, a large proportion of those of the *"rosea"* type that have been seen, have had 5 or more tentacles. This was, indeed, the case with Eschscholtz's original series of *rosea* (4 specimens, 3 with 5 tentacles, one with 6 tentacles), and has repeatedly been reported since; see especially Vanhöffen (1908a) and Uchida (1928). The present series again yields 3 pentamerous specimens among the 9 of *rosea* type just mentioned, the others having 4 tentacles each. A possible explanation is that variants of this sort are more frequent in one sex than in the other.

Reduction of the tentacles also occurs, though more rarely; the series includes one specimen of 9 mm. with only three tentacles. But it is too much contracted to allow classification, as to type.

While most authors who have written of *Aegina* have described it as having only a small number of otocysts, Vanhöffen (1908a) found about 20 per marginal sector in one of the *"rosea"* type, 16 in one of the *"citrea"* type. And while I have not been able to make a complete count of otocysts, even for a single sector, of any of the Bermuda specimens, the spacing of such of these organs as are still recognizable, or of their basal pads, is consonant with Vanhöffen's counts.

General Distribution: *Aegina citrea* is widespread in the warm belts of all oceans—this was already known to apply both to the *citrea* and *rosea* forms—also in the Mediterranean. Southward, it had been taken in the sub-Antarctic; and northward to the Bering Sea region in the Pacific; to Lat. 58° N. in the northeastern Atlantic. The present series is, however, interesting geographically because there was no previous record of *Aegina* in the western half of the north Atlantic except close to the coast (see Thiel, 1936, p. 76, Fig. 15, for a recent chart of this distribution).

Vertical Range: *Ae. citrea* has repeatedly been taken at the surface (the Bermuda series includes 2 surface hauls), but also in open nets lowered to various levels, and—more instructive—in closing nets from 1,000-700 meters (Vanhöffen, 1908a, as "*Ae. lactea*"); about 800 meters (Bigelow, 1909); 200-100, 600-400, 700-500, 800-600, and 1,030-830 meters (Thiel, 1936, "*Ae. rosea*"). Its bathic range is thus very wide.

Thiel (1935, p. 81) has also pointed out that the specimens taken deepest averaged the largest, those taken shoalest, the smallest; evidence that *Aegina*, like various other medusae, reproduces chiefly near the surface, tending to sink, with increasing age. This is corroborated by the Bermudian collection, the distribution of catches with depth being:

Depth in Meters.	Number of Specimens.
0	2
914-0	2
1,097-0	3
1,280-0	4
1,463-0	11
1,646-0	5
1,827-0	4

Aeginura.

It is now generally agreed that all representatives of *Aeginura* that have been examined recently, are referable to the wide-ranging, bathypelagic species, named *Ae. grimaldii* by Maas (1904) from the collections of the Prince of Monaco. Thiel (1936), in his historical survey of the genus, goes still further, in definitely uniting *grimaldii*, and its more recent synonyms, with the *Aeginura myosura*, *Cunoctona nausithoe*, and *C. lanzerotae* of Haeckel (1879); hence he employs the latter name (it has page priority over *nausithoe* and *myosura*). This point is discussed in an earlier publication (Bigelow, 1913, p. 60). I need only repeat here, that (quite apart from the presence or absence of a peronial canal system), if we are to conclude that the *Aeginura* of modern students is identical with these older Haeckelian species we must assume (a) that the otoporpae so clearly shown in Haeckel's (1879, Pl. 20, Figs. 1-2) illustrations of his two species of "*Cunoctona*" were imaginary; and (b) that the absence of secondary tentacles and the small number of otocysts (16 indicated) in his *Ae. myosura* were the result of mutilation. As his descriptions were based on preserved (no doubt alcoholic) material, the second assumption is not unreasonable. But there is no way to establish the correctness of either of these assumptions; and it is possible that an *Aeginura* lacking secondary tentacles and with very few otocysts, may some day be found. It, therefore, seems to me wiser to treat Haeckel's old names as doubtful synonyms of *grimaldii*, rather than to select one of them as the name for the species in question.

I need only note farther that if Haeckel's accounts were to be taken at face value, *grimaldii* could not be referred to his genus *Aeginura* at all, because he described the latter as having a well-developed canal system. But as Maas (1905, p. 78) pointed out, what Haeckel (1881, Pl. 13, Fig. 7) pictured as canals were in reality parts of the gastric pouches.

Aeginura grimaldii Maas.

Aeginura grimaldii, Maas, 1904, p. 38, Pl. 3, Figs. 19-28; Bigelow, 1909, p. 80, Pl. 9, Fig. 4; 1913, p. 61; Mayer, 1910, p. 470; Kramp, 1913,

p. 276; 1914, p. 436; 1920, p. 6; 1924, p. 37; Broch, 1929, p. 533, Fig. 37; Thiel, 1932a, p. 156; Ranson, 1936, p. 211.

Aeginura weberi, Maas, 1905, p. 77, Pl. 11, Fig. 73, Pl. 12, Fig. 76, Pl. 14, Figs. 90-99.

Cunoctona grimaldi var *munda*, Vanhöffen, 1908a, p. 53, Pl. 2, Fig. 6.

Cunoctona guinensis, Vanhöffen, 1908a, p. 53, Pl. 3, Fig. 29.

Cunoctona obscura, Vanhöffen, 1908a, p. 52, Pl. 2, Fig. 7, Pl. 3, Figs. 25-28, 30.

Aeginura lanzerotae, Thiel, 1936, p. 86.

? *Aeginura myosura*, Haeckel, 1879, p. 343, Pl. 19, Figs. 8-9; 1881, p. 41, Pl. 13-14; Mayer, 1910, p. 468.

? *Cunoctona lanzerotae*, Haeckel, 1879, p. 318, Pl. 20, Figs. 1-6.

? *Cunoctona nausithoe*, Haeckel, 1879, p. 318.

? *Aeginura lanzerotae*, Mayer, 1910, p. 469.

Material: Net Nos. 18, 22, 24, 36, 41, 48, 49, 52, 53, 64, 66, 67, 69, 73, 78, 111, 121, 122, 137, 270, 293, 295, 362, 400, 427, 442, 455, 468, 481, 539 562, 582, 605, 606, 612, 620, 621, 627, 628, 631, 632, 635, 638, 639, 645, 646, 652, 654, 665, 680, 681, 685, 698, 700, 702, 708, 712, 715, 719, 720, 721, 724, 726, 732, 740, 742, 745, 746, 753, 759, 760, 761, 778, 779, 781, 793, 794, 804, 805, 810, 811, 812, 842, 849, 852, 861, 885, 894, 959; hauls from 540-0 to 1,829-0 meters; 184 specimens, 1-6 per haul. Also, Net Nos. 26, 42, 65, 76, 110, 143, 295, 360, 447, 488, 598, 716, 929, 949; 19 specimens, probably belonging here, but so fragmentary as to preclude positive identification.

In spite of its extent, the collection adds nothing to previous knowledge of the morphology of this species, for the specimens are all in such poor condition that it is only the very characteristic appearance of *Aeginura*—especially the large tentacle roots, the outlines of gastric pockets, and the dense pigmentation—that makes them recognizable at all. It was disappointing that the margins are in every case so battered that neither the secondary tentacles peculiar to the genus, nor the otocysts, are to be seen. The very large white eggs are, however, so resistant that they are still visible in specimens from Net Nos. 111, 122, 468, 606, 726, 761, 794, 810, and 959. These catches were made in the months of May, June, July, August, and September, evidence that in this region the breeding season of *Aeginura* covers spring, summer, and early autumn—very likely the entire year.

General Distribution: The wide distribution of previous records (Thiel, 1936, Fig. 18) had already established the cosmopolitan nature of this medusa in the ocean basins. The present captures are, however, interesting as the first for the eastern side of the North Atlantic; interesting also as showing that this is one of the most regularly occurring medusae at suitable depths in the Bermuda region, which may be taken as representative of the Sargasso Sea as a whole.

Vertical Range: Up to the present, there is no positive evidence that any *Aeginura* larger than 8-10 mm. has been taken from a depth less than 400-500 meters, for while the great majority of captures have been in open nets, those taking adults have in every case sampled the water down to at least this depth—in most cases much deeper. And there is record of closing net captures of adults from about 780 meters (Maas, 1904), as well as from 1,000-700 meters and deeper (Thiel, 1935, Table 16). Thus, when adult, *Aeginura* belongs to the same bathypelagic community as *Atolla* and *Periphylla*, as indeed, its dense pigmentation would indicate. The depth distribution of the Bermuda hauls yielding *Aeginura*, relative to the total number made at each depth, tabulated below, suggests a rather definite concentration between, say, 1,000 and 1,600 meters.

Depth in Meters.	Total Number Hauls.	Number Hauls with *Aeginura*.	% with *Aeginura*.
549-0	23	1	4
732-0	40	2	5
914-0	132	9	7
1,097-0	134	19	13
1,280-0	132	27	19
1,463-0	132	19	14
1,646-0	135	17	13
1,829-0	135	8	6
2,012-0	4	0	0

Thiel (1935), however, has recently made the interesting discovery that young stages of 1-5 mm. occur in the upper water layers, the *Meteor* having taken them on four occasions shoaler than 100 meters, once shoaler than 50 meters (Thiel, 1936, p. 86). From this, he suggests that the eggs rise to the surface, and that, as growth proceeds, the young medusae sink deeper and deeper, as seems commonly to be the case among bathyplanktonic animals.

SOLMARIDAE.

Pegantha.

? Pegantha clara R. P. Bigelow.

Pegantha clara, R. P. Bigelow, 1909, p. 80; Mayer, 1910, p. 445; H. B. Bigelow, 1918, p. 397.

Polycolpa forskali, Vanhöffen, 1908a, p. 56; 1912, p. 391; 1912a, p. 32. [Non *P. forskalii* Haeckel, 1879; 1881.]

Pegantha smaragdina, H. B. Bigelow, 1909, p. 90, Pl. 14, Fig. 1, 2, Pl. 19, Figs. 1-9, Pl. 22-26.

Material: Net Nos. 50, 157, 271, 720, 812, 882, 902, 959; 914-0 to 1,463-0 meters; 8 fragmentary specimens, about 10-about 20 mm. in diameter.

Although damaged, having lost all trace of exumbral sculpture, and with the stomach much battered, the specimens all show the peronial canals, and the outlines of the stomach without any trace of gastric pockets, that are characteristic of *Pegantha*. Owing to the obvious contraction of some specimens and the flattening of others, it is not possible to state the normal relationship of heighth to breadth: in the present state they suggest that at diameters of 10-20 mm., the bell of this species is from ¼ to ½ as high as broad; perhaps still higher relatively in some cases.

The tentacles range in number from about 20 to about 24; the largest number being in a specimen of about 12 mm., while the largest specimen has only 22 tentacles. The small specimens (6 in number, 10-12 mm. in diameter) without gonads, are referred to this species chiefly because this is the only *Pegantha*, yet known, in which upwards of 18 tentacles have been found before the development of the gonads. This identification is strengthened, in the case of the 20 mm. specimen, by the fact that traces are to be seen of simple interradial swellings—forerunners of the gonads—at the margin of the stomach.

Most of the otocysts have been lost; but the spacing of those still visible suggests the presence of 3-5 per marginal lappet; or about the number to be expected in juveniles of *P. clara*, in adults of which there may be up to 8 per lappet. In only one specimen are traces of the otoporpae still to be seen.

General Distribution: The original record of *P. clara* was from the continental slope in the offing of Woods Hole, and young specimens were taken near the Bahamas by the *Bache* (Bigelow, H. B., 1918), so that it was to be expected at Bermuda. Other records referable to it are from the vicinity of the Cape Verde Islands (Vanhöffen, 1912, *"Polycolpa forskali"*), off Chile (Vanhöffen, 1912a, *"Polycolpa forskali"*), off Peru, (Bigelow, 1909, *"Pegantha smaragdina"*), and from the tropical Pacific between Hawaiian and Caroline Islands (Vanhöffen, 1912a, *"Polycolpa forskali"*).

Vertical Range: Previous records include both the surface, and open net-hauls from considerable depths.

SCYPHOMEDUSAE.

Carybdeida.

Mayer (1910) grouped all known Carybdeida in a single family—Carybdeidae. For convenience, however,—even if for no other reason—it seems preferable to follow Krumbach (1925) and Uchida (1929) in limiting that family to forms which lack gastric pouches projecting from the manubrium into the subumbrella cavity, and in which there are only 8 (adradial) marginal pockets. The more complexly organized forms with free gastric pouches and more numerous (16) marginal pockets are divided by Krumbach (1925) into 2 families, but (I believe more logically) grouped by Uchida in one, Chirodropidae. The latter need not be discussed here, as it is not represented in the Bermuda collection.

CARYBDEIDAE.

Few pelagic coelenterates came to scientific attention earlier than did the quadritentaculate members of this family, for the well known Mediterranean *Carybdea* was described by Linnaeus, (1758). Since that time, the number of named forms multiplied, until Mayer (1910) gave a list of twenty-one. It was already obvious, however, that the number of actual species represented was much smaller. And although insufficiency of most of the early descriptions precluded revision, Mayer (1910) tentatively classed all of them as varieties of four species at most. The carybdeids have subsequently been the subject of repeated discussion, notably by Stiasny (1919, 1926, 1929, 1930, 1934, 1935, 1937), by Uchida (1929), by Thiel (1928) and by Menon (1930). But views held, as to generic and specific characters, have been so divergent that a résumé is requisite, before the Bermudian specimens can be discussed even though these belong to forms known for many years.

Much of the confusion has resulted from uncertainty as to how much weight should be given (in classification) to the position of the groups of gastric filaments (phacellae); i. e., whether in clusters or horizontal bands at the 4 interradial corners of the stomach (*Carybdea* type), or extending as vertical bands along the interradial sides of the latter, as described by Müller (1858), for *Tamoya haplonema.* Unfortunately, Müller's illustration did not show the location of the filaments. And while his account of their location has repeatedly been quoted, or paraphrased, no first-hand description of this type of phacella appeared subsequently until Stiasny (1919, p. 40) found the phacellae forming "interradiale vertikale Fadenreihen längs der Magenseiten," in Sumatran specimens otherwise agreeing so closely with Müller's *Tamoya* that generic identity was assured. And in 1934 Stiasny (1934) was at last in the position to present a good illustration of a West African carybdeid, evidently referable to Müller's *T. haplonema,* · clearly showing this same vertical arrangement, with phacellae extending along ⅔ of the length of the stomach. It is thus proved that the type species

of *Tamoya* differs from the type of *Carybdea* (*C. marsupialis*, Linné) not only in the larger stomach and in the presence of mesenteries (often used as the chief generic separation), but equally sharply in the arrangement of the phacellae.

Uchida (1929, p. 175), it is true, described the phacellae as "numerous short gastral filaments in the interradial crescentic area of the stomach," for a Japanese carybdeid agreeing otherwise with *Tamoya* (i.e., in the structure of the stomach, mesenteries, and canalization), hence, no doubt correctly, referred by him to that genus. But he did not illustrate the phacellae. And Stiasny (1930, p. 10) included their arrangement as one of the alternative characters for the genera, *Tamoya* and *Carybdea*, a course followed here, as well.

On the other hand, it proves necessary to abandon size and the prominence of the exumbrella sculpture, as generic characters—also included by Stiasny in his recent synopsis—because the Bermudian collection (p. 144) verifies Agassiz and Mayer's (1902) account of the existence of at least one species with the *Carybdea* type of stomach (i.e., flat and lacking mesenteries) and phacellae, but with weak sculpture and growing to a larger size than any other carybdeid yet seen. Thus, if the generic separation is to be based primarily on structural features—and that this is the more logical procedure need hardly be defended—we arrive at the following:

1. Stomach flat, without mesenteries: gastric cirri forming brush-like bundles at the interradial corners of the stomach, or (if expanded) crescentic areas extending horizontally..................................*Carybdea.*

2. Stomach deep, connected with the subumbrella by well developed perradial mesenteries: gastric cirri in bands, extending vertically along the walls of the stomach, in the interradii...............................*Tamoya.*

This, the reader will observe, is a return to the scheme long ago proposed by Haeckel (1880); an instance where the latter's classic system has proved more prophetic of knowledge to come than it was justified by facts at hand at the time.

The family, Carybdeidae (as here defined), also includes one well known genus, *Tripedalia*, which shows a multiplication of tentacles, but otherwise resembles *Carybdea* and *Tamoya* in simplicity of organization.[14]

Carybdea.

Among the Carybdeas that have yet come to light, one, recently described by Stiasny (1930), but unnamed, is set apart by the fact that its tentacles bear lateral branches. As the tentacles in all other members of the family—whether single or grouped—are simple, this form certainly deserves specific recognition. The new species, *Carybdea stiasnyi*, is therefore proposed for it. Stiasny (1930, p. 5) suggests that "auf Grund dieses einen Merkmals könnte ein neues Genus aufgestellt werden." But in this regard, we may well await the action of its discoverer.

Successive studies by different authors have brought cumulative evidence to support Mayer's (1910) contention that all other named forms of *Carybdea* in reality represent nothing more than varieties or races of a very small number of good species. But views have differed as to how many such deserve recognition, largely because of the uncertainty as to which, if any, of the supposed "Carybdeas," should actually be referred to its companion genus, *Tamoya*. A survey of recent literature, added to the specimens I have myself seen, corroborates Mayer's (1910) view that the great majority of Carybdeas, the generic identity of which is established by adequate descrip-

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[14] Haeckel's (1879-80) problematical genera *Procharagma* (lacking velum) and *Procharybdis* (with velarium, but lacking velar canals) would also fall among the Carybdeidae. should it ever prove that any existing carybdeids show these primitive states when adult, i. e., that they were not founded either on multilated specimens, or on juvenile stages.

tion or by illustration of the critical characters, fall in one or other of the following well differentiated groups:

Group A. Of small or moderate size (for the most part less than 50 mm. high) ; with strong exumbral sculpture; with the gastric cirri in each cluster arising either from a single basal stalk or from stalks closely clustered at the four interradial corners of the base of the manubrium. The earliest named *Carybdea, C. marsupialis* Linné, of the Mediterranean, was of this type; so also two other well known forms, *C. xaymacana* Conant from the West Indian region, and *C. rastonii* Haacke of the Indo-Pacific—likewise *C. murrayana* Haeckel, from West Africa.

Mayer (1910, p. 508) in his tabular view classes *xaymacana* as a variety of *marsupialis* from which it differs only in somewhat smaller size, in having fewer and less complexly branched velar canals (4 per quadrant instead of up to 6 or 8), and phacellae arising from a single primary trunk, instead of from 8-10 primary branches.

The unity between *xaymacana* and *marsupialis* with respect to the phacellae is in fact, even closer than Mayer supposed. On the one hand, Claus (1878) long ago pointed out that in *marsupialis* each group of filaments arises from a single main trunk, while on the other, my own examination of Bermudian and Bahaman specimens of *xaymacana* described below (p. 139) shows that the basal trunk divides into several primary branches, each of which bears a cluster of filaments either simple, or showing further dendritic branching (Text-figs. 3, 4, 5), much as described for *marsupialis.* Nor are there any differences in the outline of gonads and of pedalia, in the shape of the rhopalar nitches, or in exumbral sculpture, that can not be explained as due to contraction, or—at most—to individual variation.

Comparison does, however, substantiate the supposed difference in canalization, for whereas in the *xaymacana* that I have seen, as well as in those described by Conant (1898), by Mayer (1910), and by Stiasny (1919), there have been at most four (sometimes three, according to Stiasny), unbranched or simply forked canals per quadrant, there may be 6 or even 8 in *marsupialis,* some of them complexly subdivided. In canalization, then, *xaymacana* corresponds to half-grown *marsupialis;* as it does in the fact that the largest so far seen (with large gonads) have been only ½ to ⅔ as high as mature *marsupialis.*

Present indications, therefore, are that *xaymacana* is a dwarf—perhaps paedogenetic—form of *marsupialis;* one, too, with a different geographic distribution, for the typical (*marsupialis*) form has never been seen in the western side of the Atlantic, nor the dwarf (*xaymacana*) form in the eastern. Furthermore, *C. murrayana* bears much the same relationship to *marsupialis* that the latter does to *xaymacana,* for while it agrees with *marsupialis* in sculpture and in the structure of its phacellae, its velar canals are not only more complexly branched than in typical *marsupialis,* but more numerous, i.e., 10-12 per quadrant. It is, indeed, doubtful whether a half-grown *murrayana* would be distinguishable from a full-grown *marsupialis*—except perhaps, by the state of development of the gonads—or a half-grown *marsupialis* from a fully-grown *xaymacana,* though there would be no danger of confusing full-grown specimens.

Forms bearing a relationship of this sort, one to the other, would unhesitatingly be named "subspecies" by students of molluscs, of crustacea, or of the higher vertebrates. And as they certainly require recognition in nomenclature, more precise than the vague designation "variety," it seems justifiable to introduce trinomials into the classification of pelagic coelenterates, also, to cover such cases.

The discussion must also touch on the status of *C. rastonii,* because if the latter be, in fact, indistinguishable from *xaymacana,* as Stiasny (1919) has suggested, the combined subspecies must be named *rastonii* Haacke

(1886), this being the older of the two names; or perhaps even *prototypus* or *cuboides*, if it finally prove that Haeckel's (1880) problematical *Procharagma prototypus* and *Procharybdis cuboides* are young *rastonii* as Mayer (1910, p. 509) has classed them.

Apart from geographic distribution, the only distinctions between *xaymacana* and *rastonii,* listed in Mayer's (1910) tabular view, are slight differences in shape and relative length of pedalia, and in length of tentacles, which certainly would not justify separation. Furthermore, the canalization of *rastonii* is intermediate, in type, between that of typical *marsupialis,* and of the subspecies, *xaymacana.*

On the other hand, *rastonii* does differ from *xaymacana* in the structure of its phacellae, for, whereas in *xaymacana* all, or most of the primary branches arise from a single basal trunk (p. 140), in *rastonii* they arise independently from the gastric wall, in a row, flanked on either side by several simple cirri, as long ago described by Haacke (1887, Pl. 35, Fig. 4), a state derived (in young medusae) from a row of simple cirri.[15] And this difference, by which specimens of *rastonii* can be recognized at any stage after the appearance of the gastric cirri, seems sufficient to warrant its continued recognition as a distinct species, to emphasize the fact that the Indo-Pacific representative of this group differs more widely from the Atlantic representatives, than do the latter, one from another.

Group B. This group includes much larger forms up to 230 mm. high; relatively narrower in outline than the *marsupialis* group; with weak exumbral sculpture, if any; with the gastric cirri grouped along crescent-shaped rows centering at the interradial corners of the base of the gastric cavity. Recent collections have repeatedly yielded large *Carybdea* of this type, most frequently reported as *C. alata* Reynaud, as *C. grandis* Agassiz and Mayer, as *C. moseri* Mayer, or as one or other of the last two considered as a variety of the first. According to various accounts the group differs also from the *marsupialis* group, in the form of the pedalia, in the relative heighth of the rhopalia above the bell margin; in the outline of the rhopalar nitches, and in the more numerous velar canals, as described below (p. 146, 147).

The earliest named form that can be positively referred to this group (because of the distinctive characters of bell and of phacellae) was *C. grandis* Agassiz and Mayer (1902) from the tropical Pacific, half-grown individuals (or a dwarf race) of which were redescribed shortly afterward by Mayer (1906) as *C. moseri.* But it seems probable that *C. alata* Reynaud (1830) was based on a young *Carybdea* of this same type, for the original illustration shows a rounded, non-sculptured bell, nor is there anything in Reynaud's illustration or account to argue to the contrary. Consequently, Vanhöffen (1908) revived the name *alata,* for Carybdeas from the Indian Ocean and Straits of Malacca, that agreed with *grandis* in canalization and in structure of phacellae. Mayer in his tabular view (1910, p. 508), followed Vanhöffen in classifying both *grandis* and *moseri* as varieties of *alata* Reynaud, as have subsequent authors, generally.[16] And while one must admit that it will never be possible to determine, with absolute certainty, the identity of the specimen pictured by Reynaud, because no description was given of the morphological features on which identification primarily depends, to follow Vanhöffen will tend toward stability of nomenclature. The situation is, however, confused by the fact that Uchida (1929), while agreeing that *grandis* and *moseri* belong in the synonymy of *alata* Reynaud, transferred the latter name to a species of *Tamoya,* on the supposition that Agassiz and Mayer's (1902) original figures of *grandis* referred to a member of that genus, not to a *Carybdea.* And this course has been followed by Stiasny (1929;

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[15] I have been able to confirm Haacke's (1887) account of stages in development for small and middle-sized specimens from the tropical Pacific (Bigelow, 1909), and for a large series from Japan, in the collection of the Museum of Comparative Zoology.

[16] Thiel (1928) has revived the name *grandis.*

1930, 1935, 1937), likewise by Rao (1931). Successive examinations of specimens of the *alata-grandis* type have, however, proved that actually they have the shallow stomach and the arrangement of phacellae characteristic of *Carybdea.*

So far as can be judged, from published accounts, and by the specimens (Atlantic and Pacific) that I have myself examined, the members of the *alata-grandis* group, so far named, represent only one species, including *C. madrasputana* recently described by Menon (1930) which seems to represent an immature stage in development. It is even doubtful whether any of the named forms deserve the term variety.

Group C. Mayer (1900; 1910) described (as *C. aurifera*) a juvenile *Carybdea* from the Tortugas, differing from *C. xaymacana* in the facts that the velar canals next the tentacular radii were broadly palmate, and that the exumbrella was sprinkled with nematocyst warts, as well as in strong coloration. Recently, Stiasny (1926) has described a second species, *C. sivickisi,* from the Philippines, in which all the canals are of this palmate form, and with similarly warty exumbrella. Its rhopalar nitches also differ from those either of the *marsupialis* group, or of the *alata* group, in lacking a well-developed covering scale. But it is separated from *aurifera* by the fact that its exumbrella is strongly sculptured; that it has large gonads though only slightly larger (10-12 mm. high, as against 7 mm.); and in the tentacles and sensory nitches. Examination of a larger series alone can show how far these differences can be credited to different stages in growth; especially since Mayer's figures of *aurifera* are evidently somewhat diagrammatic and conflicting as regards the phacellae; meantime the two species are best retained.

Summation of the foregoing yields the following synopsis of *Carybdea,* as here recognized:

1. Tentacles simple.
    A. Sensory nitches overhung by well developed covering scales; exumbrella not warty.
        a. With prominent exumbral sculpture; sensory nitches with covering scale above, but entry open below.
            (1). Phacellae dendritic, the filaments primarily arising from a single trunk...
                 marsupialis (including *xaymacana* and *murrayana*).
            (2). Phacellae more diffuse, of several trunks arranged in a row ....*rastonii.*
        b. Exumbrella without prominent sculpture; sensory nitches enclosed by a pair of scales below, as well as by one above...*alata.*
    B. Sensory nitches without well developed covering scale, exumbrella warty ....*sivickisi (aurifera?).*
2. Tentacles bearing lateral branches..*stiasnyi.*

Carybdea marsupialis xaymacana Conant.

Charybdea xaymacana, Conant, 1897, p. 8, Fig. 8; 1898, p. 4, Figs. 1-16, 31-34, 36-43, 57, 67, 69, 70, 72; Berger, 1898, p. 223; 1900, p. 1, 3 pls.; Mayer, 1904, Pl. 7, Fig. 60; 1910, p. 509, Pl. 56, Figs. 5-7, Pl. 57, Fig. 1; Stiasny, 1919, p. 34.

Tamoya punctata, Fewkes, 1883, p. 84, Pl. 1, Figs. 4-6.

Material: Net No. 745, Surface, June 29, 1930, 4 specimens, about 12-23 mm. high.

Net No. 840, Surface, September 3, 1930, 1 specimen, about 11 mm. high.

Dip net, Surface, October 16, 1930, 1 specimen about 15 mm. high.

Net. No. 935, 1,463-0 meters, September 23, 1930, 1 specimen, about 19 mm. high.

Net No. 977, Surface, May 12, 1931, 14 specimens, about 10-20 mm. high.

Net No. 978, Surface, May 15, 1931, 18 specimens, about 10-18 mm. high.

Net No. 979, Surface, May 16, 1931, 66 specimens, about 10-19 mm. high.

The general features of *xaymacana*, including exumbral sculpture, need no comment here, having been well described by Conant (1898) and by Mayer (1910); the phacellae, and rhopalar nitches in more detail by Stiasny (1919). But notes are pertinent on the range of variation in these respects, and on the branching of the velar canals, questions bearing on the relationship of this form to typical *marsupialis* on the one hand, and to *rastonii* on the other.

Phacellae: Conant (1898) and Stiasny (1919) both describe the gastric cirri of each group as arising from a single trunk, as is likewise the case

Text-fig. 4.
Carybdea marsupialis xaymacana. One of the groups of phacellae from a specimen 23 mm. high (Net No. 745). x 30.

Text-fig. 3.
Carybdea marsupialis xaymacana. One of the groups of phacellae from a specimen 16 mm. high (Net No. 745), showing the typical state in which the filaments all arise from a single primary trunk. x 30.
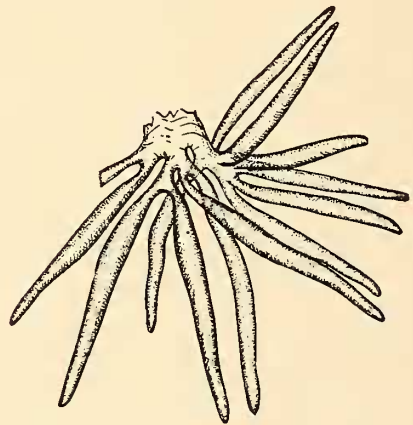
Text-fig. 5.
Carybdea marsupialis xaymacana. One of the primary branches, with terminal filaments, from the group of phacellae shown in Text-fig. 3.

in most of the Bermudian specimens (Text-fig. 3). And while in one of the clusters in the specimen from Net No. 745 (Text-fig. 4), there is a secondary cluster of filaments close beside the primary group (the other 3 phacellae are of the more usual type), the fact that the primary trunk invariably bears most, if not all of the cirri, is a ready distinction between *xaymacana* and juvenile *alata* of the same size (p. 147).

According to Stiasny (1919, p. 36), the filaments are not branched[17]; and they present this same appearance of simplicity when viewed through the bell wall. But when the groups are dissected out and the filaments teased apart (Text-figs. 3-5), it is seen that actually, the basal trunk gives rise to several primary branches, each of which in turn divides, close to the base, into a group of filaments, much as is the case in the typical *marsupialis* (p. 137). In one group, 5 such primary branches were detected, with a cluster of juvenile filaments at one side, apparently forecasting the development of a sixth; the total number of filaments being about 40 (Text-fig. 3).

Canalization: Up to the present time, Stiasny (1919) alone has reported any variation (3) from the number of velar canals per quadrant (4) originally reported by Conant; even when most deeply forked, the 4 primary trunks are identifiable as such in all specimens I have seen. However, the present series amplifies earlier accounts, in showing considerable variation in the degree and type of branching. Conant's (1898, Figs. 3-5) original figures pictured all of the canals, in adult medusae, as forked, either bifid or trifid. Mayer's (1910, Pl. 56, Fig. 7) illustration, however, shows each of the four canals in one quadrant as four-branched. And the present series proves that there may be as many as 5 terminal subdivisions, with indications even of a sixth (Text-fig. 6). On the other hand, Stiasny (1919) found most of the canals in Haitian specimens of large size (22-25 mm. high) to be unbranched, except for a tendency to dichotomous division at the tips. And the Bahaman specimens listed above are of this same type, the canals being simple (Text-fig. 7), though the specimens—evidently full-grown, or nearly so, judging from the large gonads (p. 144.)—are otherwise indistinguishable from the Bermudian series, and from the specimens originally described by Conant (1898) from Jamaica. Since both the simple types of canalization and the more complex have been found in the West Indian region (and exclusively one or the other at any one locality on a given occasion), it is likely that we have here to do with a case of what has been termed "swarm" variation.

The Bermudian series, added to earlier accounts, shows that when the canals are branched, there is much variation in the degree and type of subdivision, even from canal to canal in a given individual, though in most (if not all) cases, it is primarily a dendritic forking, very different from the lateral lobation such as characterizes *Tamoya* (p. 154, Text-fig. 22). And only a very rough correlation—if any—exists between the complexity of branching and the size of the medusa. Thus, the canals may already be bifid and trifid, in specimens not more than 10-14 mm. high as exemplified by the specimen from Net No. 745. One of 19 mm., shows much the same state, but one of 23 mm. (Text-fig. 6) shows a somewhat more complex branching. In most cases, the canals next the tentacular radii are somewhat more complexly branched than those next the rhopalar radii (Text-fig. 6); occasionally, however, one of the latter may have as many as four well developed branches.

Pedalia: The only variations, worth mention, from the shape illustrated by Conant (1898) and by Mayer (1910) are slight individual differences in the precise outline of the fin-like basal expansion of the inner (oral) side

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[17] Conant (1898, p. 14) was not explicit on this point.
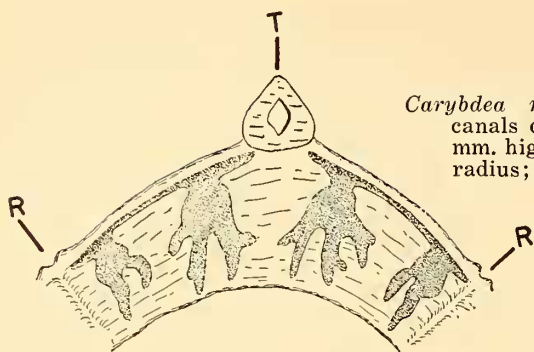
Text-fig. 6.

Carybdea marsupialis xaymacana. Velar canals of one quadrant of specimen 22 mm. high (Net No. 745). **T.,** Tentacular radius; **R.,** Rhopalar radius. x about 6.
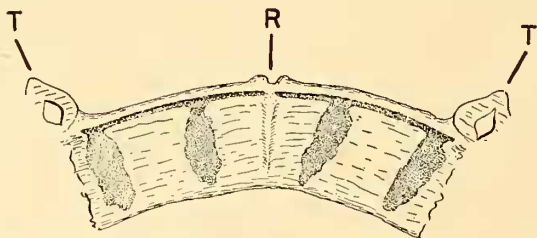
Text-fig. 7.

Carybdea marsupialis xaymacana. Velar canals of one quadrant of Bahaman specimen about 23 mm. high. x about 5.

(Text-fig. 8). And these are so slight as to be perhaps explicable as contraction phenomena (Text-fig. 8). The pedalia of all I have seen agree very closely with these structures in an excellent specimen of typical *marsupialis* from Naples with which I have been able to compare them; also with *rastonii* (Bigelow, 1909, Pl. 10, Fig. 1; Uchida, 1929, Fig. 60A). The lengths of the pedalia, in terms of bell height, in a series of 10 specimens ranging in height from 10 mm. to 23 mm., are as follows:

Net No.	Bell Height.	Length of Pedalia.[18]	Pedalia, % of Bell Height.
977	10	6 .	60
745	12	5	42
977	15	7	47
977	16	8	50
977	17	8	47
977	17	8	47
977	17	8	47
745	19	8	42
935	20	9	45
745	23	10	43

The foregoing shows some slight but irregular decrease in the relative length of the pedalia with the growth of the medusa; the average of 43% confirms Mayer's (1910) report of between ½ and ⅓ the bell heighth.

[18] Measured from the base of the fin-like expansion to the origin of the ringed portion of the tentacle.

Text-fig. 8.

Carybdea marsupialis xaymacana. Pedalia to show variations in outline. **A.**, From specimen 14 mm. high from Jamaica; **B.**, From Bahaman specimen 23 mm. high.

A   B
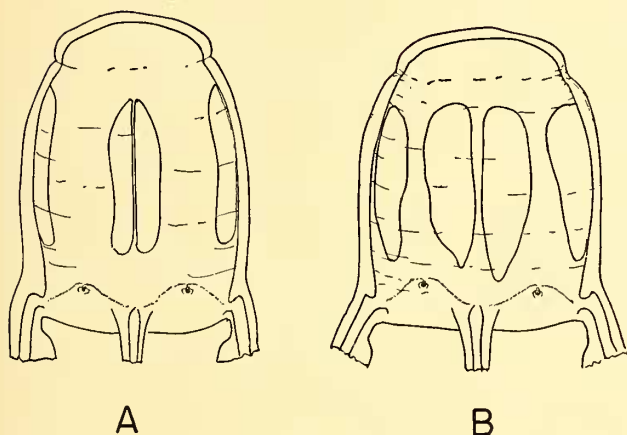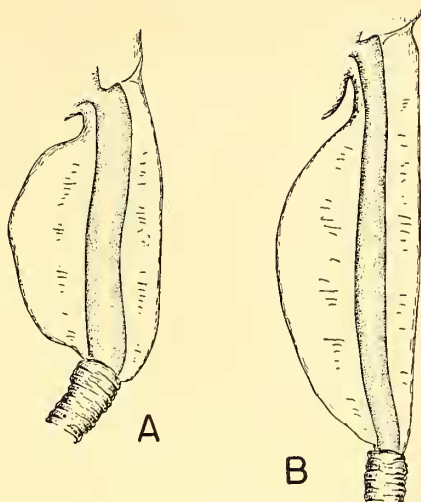
Text-fig. 9.

Carybdea marsupialis xaymacana. Outlines of two specimens about 20 mm. high to show variations in breadth and outlines of gonads. **A.**, From Net No. 979; **B.**, From Net No. 935.

Gonads: The feature which shows most obvious variation, among preserved specimens of a given size, is the relative length and breadth of the gonads. In their final state (Conant, 1898, Pl. 1, Fig. 1), these extend distally, nearly to the margin of the bell. None of the Bermudian or Bahaman specimens are, however, as far advanced as this. In the largest of the former, the gonads reach only to about the level of the distal ends of the rhopalia. In specimens 17-18 mm. high, i.e., ⅔ grown, the gonads terminate about as high above the rhopalia as are the latter above the bell margin. Among the Bermudian series, the gonads in specimens 18-23 mm. high vary from narrow-linear, to so wide that their free margins are close together (Text-fig. 9). Furthermore, the lamellae from which the sex organs arise, may be either so narrow that the gonads of each pair seem almost in union (Text-fig. 9A), or so wide that they are separated by a considerable space

(Text-fig. 9B). This last may mirror, simply, a flaccid condition. But the variation in length of the gonads, in specimens of equal size, is evidence that the growth of these organs does not necessarily parallel the growth rate of the medusa as a whole.

So far as can be determined in surface view, the Bermudian specimens are all males. Both sexes are, however, represented among the Bahaman series, the females being recognizable by the large eggs with which the leaf-like gonads are crowded, and which are easily visible with a hand lens.

Rhopalar Nitches: The present series confirms Stiasny's (1919) observation that the outlines of the pits in which the rhopalia are situated, and of the scales that partially cover the pits, offer specific characters in this genus. As Conant (1898, Pl. 1, Fig. 1) long ago showed (and Stiasny, 1919, Fig. 2 more recently), the covering scale of *xaymacana* (Text-fig. 10) has a simple undulatory outline, and the nitch is wide open toward the bell margin, i.e., there are no subsidiary scales such as characterize *C. alata* (p. 146). This is also true of typical *marsupialis*, as pictured by Claus (1878, Pl. 1, Figs. 1, 2), and as I have been able to verify on the specimen mentioned above; also in *C. rastonii* (Bigelow, 1909, Pl. 10, Fig. 1, 4; Uchida, 1929, Fig. 61).
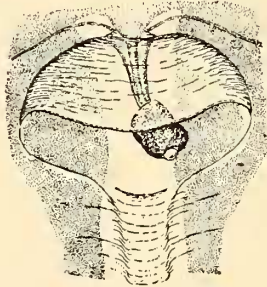
Text-fig. 10.
Carybdea marsupialis xay-macana. Sensory pit, with covering scale, of a Bahaman specimen. x about 10.

General Distribution: Previous records of *xaymacana*, under this name, are all from the West Indian region; Jamaica (Conant, 1898); Bahamas (Mayer, 1904; 1910); Haiti (Stiasny, 1919). But it is no surprise to find it near Bermuda, for it is probable that the *T. punctata* recorded thence by Fewkes (1883) was actually a young *xaymacana*.

Vertical Range: The list of captures (see above) confirms previous experience that the species occurs chiefly close to the surface.

Carybdea alata Reynaud.

Carybdea alata, Reynaud, 1830, p. 95, Pl. 33, Fig. 1; Haeckel, 1880, p. 441; Vanhöffen, 1908, p. 34; Mayer, 1910, p. 510; Bigelow, 1918, p. 400.

Marsupialis alata, Lesson, 1843, p. 276.

Tamoya alata, L. Agassiz, 1862, p. 174; Rao, 1931, p. 27 [partim].
——, Semper, 1863, p. 561, Pl. 39, Figs. 8, 9.

Charybdea pyramis, Haeckel, 1879, Pl. 25, Fig. 5-8; 1880, p. 440.

Charybdella alata, Haeckel, 1880, p. 441.

Charybdea grandis, Agassiz and Mayer, 1902, p. 153, Pl. 6, Figs. 26-31; Bigelow, 1909, p. 19; Thiel, 1928, p. 4.

Charybdea moseri, Mayer, 1906, p. 1135, Pl. 1, Figs. 2-26.

Carybdea alata var. *pyramis*, Mayer, 1910, p. 511.

Carybdea alata var. *grandis*, Mayer, 1910, p. 511; 1915, p. 171; 1917,
   p. 189; Light, 1921, p. 26.

Carybdea alata var. *moseri*, Mayer, 1910, p. 512; Light, 1914, p. 196;
   Stiasny, 1919, p. 37.

Charybdea madraspatana, Menon, 1930, p. 3, Pl. 1, Fig. 3.

? ———, Semper, 1863, p. 561, Pl. 39, Fig. 8.

? *Charybdella philippina*, Haeckel, 1877, No. 404.

? *Charybdea philippina*, Haeckel, 1880, p. 440.

? *Charybusa obeliscus*, Haeckel, 1877, No. 406.

? *Charybdea obeliscus*, Haeckel, 1880, p. 441.

? *Charybdea* sp? Browne, 1905, p. 157.

Non *Tamoya alata*, Uchida, 1929, p. 172; Stiasny, 1929, p. 196; 1930,
   p. 5; 1935, p. 10; 1937, p. 210.

Material: Net No. 448, 732-0 meters, September 9, 1929, 1 specimen,
about 75 mm. high.

Net No. 459, 732-0 meters, September 11, 1929, 1 specimen, about 20
mm. high.

Net No. 663, 732-0 meters, June 4, 1930, 1 specimen, about 80 mm. high.

Net No. 979, Surface, May 16, 1931, 1 specimen, about 90 mm. high.

Also, 4 specimens, 55-63 mm. high, from Jamaica, in the collection of
the Museum of Comparative Zoology.

For the reasons for the choice of *alata* Reynaud (1830) as the name for
this species, see p. 138. Apparently, the next record of it was one of Semper's
(1863, Pl. 39, Fig. 9) unnamed carybdeids from the Pacific; while a sec-
ond of his unnamed forms (Semper, 1863, Pl. 39, Fig. 8), may have been
a young stage of it, judging from the number (6) of canals in one quad-
rant.[19] It is for this same reason that *C. obeliscus* Haeckel is provisionally
included here in the synonymy of *alata*. As Mayer (1910) has already de-
cided, this seems certainly to apply to Haeckel's *C. pyramis*, for the latter
had not only the number of canals now known to be characteristic of
alata, but also the lunate groups of phacellae, while the relatively great
length of its pedalia is explicable as associated with the small size of Haeck-
el's specimen (20 mm. high).

So far as I am aware, *alata* was not seen again until 1902, when Agassiz
and Mayer gave the first adequate description of it (large adult), from the
tropical Pacific, as *C. grandis*, followed by Mayer's (1906) account of half-
grown (or dwarf) examples, from the Hawaiian Islands, as *C. moseri*.
Browne (1905) had meantime reported, from Ceylon, a small *Carybdea* that
may have been of this parentage, though its velar canals were less numer-
ous. Soon thereafter it was reported from the South Seas (Bigelow, 1909,
p. 20) and from Philippine waters (Mayer, 1915; 1917, "*C. alata* var.
grandis").

Since that time, specimens definitely referable to *alata* have been re-
ported from Sumatra (Stiasny, 1919) and from the west tropical Pacific
(Mariana Islands, Thiel, 1928) in the one hemisphere, from the Florida-
Bahamas region (Bigelow, 1918) and from unnamed Atlantic localities
(Thiel, 1928) in the other. The figures by Menon (1930) of his *C. madras-
patana* from India, also agree closely with *C. alata*, so far as general form
and shape of pedalia are concerned, while the depression of the apex, thought
by him to be distinctive, seems more likely to have been the result of con-
traction, or of distortion. And as the large number (up to 10) of canals

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[19] This later formed the basis for Haeckel's (1880) *Charybdea philippina*.

per quadrant, reported (but not figured) by Menon may likely be derivable from the primary 6, characteristic of *alata*, it seems probable that *madraspatana* belongs in the synonymy of the latter. Some of the specimens recorded by Rao (1931) as *Tamoya alata* seem also to belong here, because of the number (6 per quadrant) and simplicity of their canals, whereas others (because of complexity of the latter) seem to have been true *Tamoya*.

As no account—other than Reynaud's (1830) original—of the Atlantic representatives of this species has ever appeared, details are added here, as warrant for definitely uniting it with its Indo-Pacific relative. The latter has been redescribed by Stiasny (1919).

General Form: The Atlantic series agrees with previous accounts in being not only of large size, and in the absence of any pronounced exumbral sculpture, but in the fact that the bell is relatively narrower than in any member of the *marsupialis* group; measurements are as follows:

Net No.	Approximate Height in mm.	Approximate Breadth in mm.	Pedalia, % of Bell Heighth.
459	20	14	70
663	80	43	56
979	85-90	42	50 (approx.)
Also,			
Jamaica	63	35	55
"	60	35	60
"	60	35	60
"	55	35	64
			62%, average

In the Indo-Pacific examples, measured by Agassiz and Mayer (1902), by Mayer (1906; 1915; 1917), and by Stiasny (1919), the width also averaged 50-60% of the height, contrasting with an average of about 80% in *xaymacana*, and in the *marsupialis* group generally. However, there is no specific discontinuity in this respect—not, at least, in preserved specimens—for Mayer (1915; 1917) has reported large *alata* (as var. *grandis*) from the Philippines, in which the heighth was 73% and 81% of the breadth. It should be noted, however, that preserved specimens are usually so much flattened that breadth is exaggerated. And the better preserved of the *alata* I have seen all taper toward the apex, which is not normally the case in *marsupialis* and its immediate allies.

In the specimens of *alata* I have seen, exumbral sculpture has been confined to a faint trace of a circumferential furrow, at the level of the base of the stomach, and to the prominences in which the rhopalar nitches are situated; nor has any trace of the longitudinal ridges and furrows, so prominent in the *marsupialis* group, been reported by any observer for *alata;* neither have nettle warts.

Rhopalia: In the largest two of the Bermudian specimens, the distance of the rhopalia above the bell margin equals about 12% of the bell heighth; about 15% in the somewhat smaller Jamaican examples, about 15-20% in the smallest Bermudian, while in Indo-Pacific specimens, so far measured, it has ranged from 13-19% (Agassiz and Mayer, 1902; Mayer, 1906; 1915; 1917; Stiasny, 1919).

Rhopalar Nitches: The series confirms Stiasny's observation that these differ from the nitches of the *marsupialis* group, in being partially covered, on the side toward the bell margin, by scale-like projections of the umbrella on either hand, in addition to the roof-like scale that overhangs the nitch

from above; a difference illustrated by Text-fig. 10, compared with Text-fig. 11 (cf. also Text-fig. 20 of *Tamoya haplonema*).
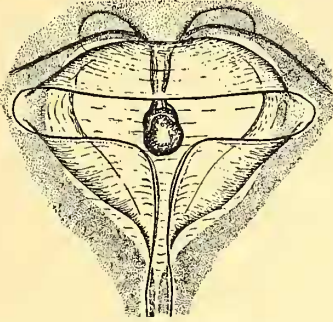
Text-fig. 11.
Carybdea alata. Sensory pit, with covering scales, of specimen from Net No. 979. x about 6.

Gonads: No gonads are visible on the 20 mm. specimen, but as this is in poor condition, they may have been lost. In the 80 mm. specimen, they reach about to the level of the rhopalia; to a point about halfway between the latter and the bell margin in the 90 mm. specimen. Perhaps as the result of contraction of the bell, they overlap somewhat near their upper ends in the 80 mm. specimen (Text-fig. 12).

Stomach: As the name *alata* has also (but incorrectly) been applied to a *Tamoya* from the Indo-Pacific, it should be emphasized, as Stiasny (1919, p. 37) has pointed out, that in *Carybdea alata*, the stomach is flat and with very short lips, much as it is in *C. marsupialis*, and with no trace of mesenteries; indeed it is so shown in Agassiz and Mayer's (1902) and Mayer's (1906; 1910; 1915) illustrations.

Phacellae: Previous students have already shown that the numerous gastric cirri of each group, occupy crescentic areas extending horizontally, at the corners of the stomach (Text-fig. 12), an arrangement differing sharply from the dendritic phacellae of the *marsupialis* group (p. 140); but no detailed account of these structures in *alata* has yet appeared. In the best preserved of the Bermudian series, the 4 crescents occupy about ⅔ of the periphery of the stomach (Text-fig. 12) confirming Agassiz and Mayer's and Mayer's illustrations. Stiasny (1919, p. 37) has described the filaments as "einfach, unverzweigt." And in surface view, the Bermudian specimens presented this same appearance. But when one cluster (Text-fig. 13) was dissected, and its component filaments spread apart it proved that the latter are the terminal branches of numerous primary trunks, standing in a single row. In most cases, a primary trunk bears 2-8 such branches (Text-fig. 14). It is the fact that the end filaments are much longer than the (very short) primary trunks that gives the deceptive appearance of simplicity. In one group of phacellae examined, there were approximately 20 primary trunks, and more than 75 filaments. As Uchida (1929) has expressed doubt, whether Atlantic specimens earlier recorded by me (Bigelow, 1918, p. 400) as *alata* really belonged to this species, I may note that one of these in the collection of the Museum of Comparative Zoology, has phacellae of this same type, besides agreeing with the Bermudian series in other respects.

The fact that the small specimen, 20 mm. high, has only 6-8 primary trunks, in each crescentic cluster, contrasted with the much larger number in large specimens, gives a measure of the increase in number that takes place with growth.

Canals: All recent accounts credit this species with 6 velar canals per quadrant, as is also true of the Bermudian specimens (Text-fig. 15); evi-
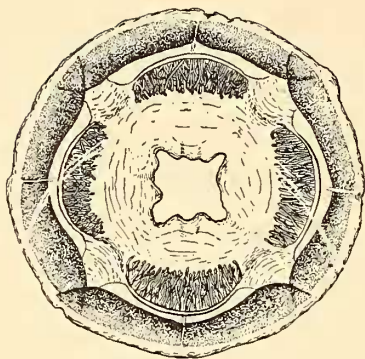
Text-fig. 12.

Carybdea alata. Somewhat schematic apical view of specimen 75 mm. high, from Net No. 448, to show the location of the lunate groups of gastric filaments.
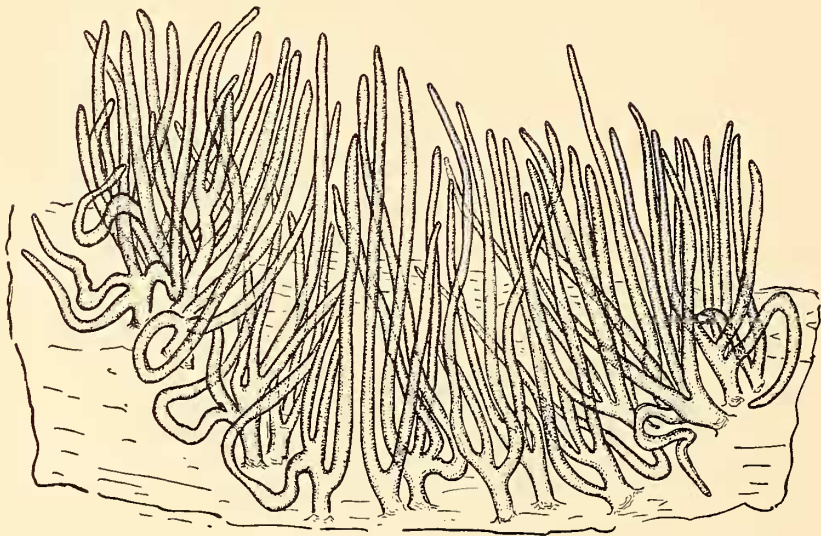
Text-fig. 13.

Carybdea alata. One cluster of gastric filaments, specimen from Net No. 448. x about 12.

dently, variants from this state are rare, except that a canal next one of the tentacular radii may be so deeply cleft that unless it be traced back to its proximal end, it might appear that the primary number was greater (Text-fig. 15B). Evidence thus accumulates to the effect that the number of canals is a dependable specific difference between *alata* and the *marsupialis* group (p. 141). Accounts have, however, differed widely as to the extent to which the canals branch. On the other hand, Mayer (1906) and Stiasny (1919) have described them as simple, or at most as showing the commencement of division. But Agassiz and Mayer (1902), copied by Mayer (1910), picture them as digitate, with short lateral lobes, while in Vanhöffen's (1908) two specimens, they were variously forked—those of the tentacular radii usually the most deeply. And the two large Bermudian specimens not only show forking, with similar contrasts between the perradial and the interradial pairs, and with complexity increasing with growth (cf. Text-fig. 15A with Text-fig. 15B), but also with wide variation from octant to octant even of

Text-fig. 14.

Carybdea alata. One primary branch
with terminal filaments, from the
group of phacellae in Text-fig.
13.

A

B
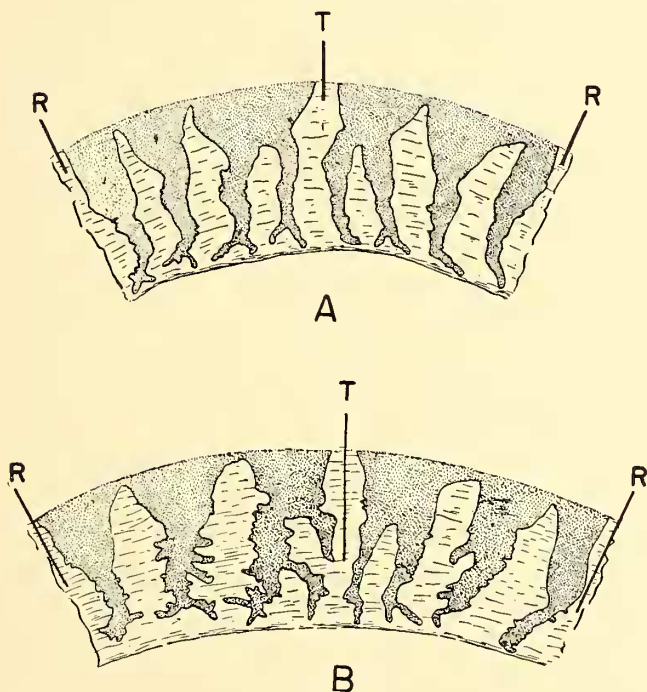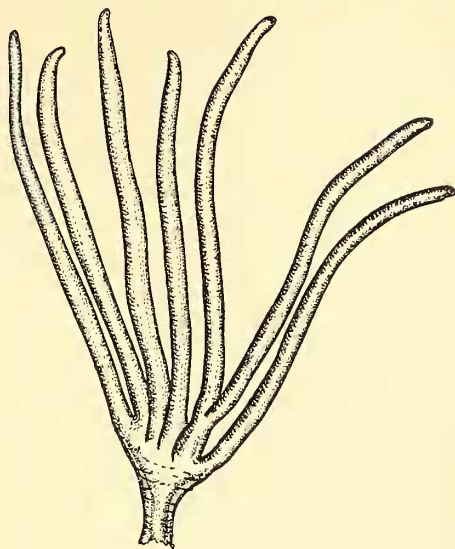
Text-fig. 15.

Carybdea alata. To show velar canals. **A.,** One quadrant
of velarium of specimen about 75 mm. high from
Net No. 448; **B.,** One quadrant of specimen about
90 mm. high, from Net No. 979. **T.,** Tentacular
radii; **R.,** Rhopalar radii. x about 3.

a given specimen, in the precise degree of subdivision, and in the lateral lobing of the canal margins.

Pedalia: By earlier accounts, and in the Bermudian and Jamaican series, the length of the pedalia (measured along the inner edge) equals about 25-30% of the bell heighth, in medium-sized specimens of 60-90 mm. In larger specimens they are relatively shorter: 17% according to Agassiz and Mayer (1902) at a bell heighth of 230 mm. In young specimens they are relatively longer: 33% in the Bermudian example of 20 mm.; and shown as about 50% in a young medusa by Agassiz and Mayer (1902).

The fin-like expansions of the pedalia are relatively narrower in the Bermudian and Jamaican specimens (Text-fig. 16) than they are pictured by Agassiz and Mayer (1902, Pl. 6, Fig. 37) or by Mayer (1906, Pl. 1, Fig. 2; 1917, Fig. 3); their outlines less pronouncedly semi-lunar. But this may well be the result of different states of contraction, between preserved and fresh material.
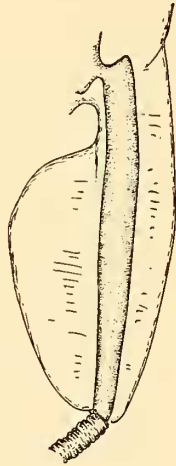
Text-fig. 16.
Carybdea alata. Basal part of tentacle of specimen from Net No. 448.

General Distribution: The wide distribution, Atlantic and Pacific, of locality records for this species (listed above), suggests that it is cosmopolitan, in the warm belts of the oceans. But it probably does not occur in the Mediterranean (perhaps barred thence by low water temperatures), for it could hardly have been overlooked there.

Tamoya.

If the *Bursarius cytherae* of Lesson (1830, p. 108, Pl. 14, Fig. 1) was, in fact, congeneric with the form later named *Tamoya* by F. Müller (1858), as Haeckel (1880) suggested, it would be necessary to substitute *Bursarius* as the generic name. However, as Haeckel pointed out, Lesson's account and illustration differ from all known carybdeids in showing only 2 tentacles (though 4 pedalia); nor do they give any indication as to the structural characters which determine generic position in this group. It is thus wisest to abandon the name *Bursarius* for good and all, on the ground that the type species of the genus is and must always remain unrecognizable. For this same reason the specific name *bursaria*, substituted by Haeckel (1880) for Lesson's *B. cytherae*, is likewise best regarded as a *nomen nudem*.

During the years that have elapsed since the type species of the genus *Tamoya* (*T. haplonema*) was described by Müller (1858), carybdeids that can be referred to this genus as here defined[20] have been described from the two sides of the Atlantic (Haeckel, 1880, as "*T. prismatica*"; Mayer, 1910; Stiasny, 1934); from Samoa (Haeckel, 1880); from Japan (Uchida, 1929); from the Malay Archipelago (Stiasny, 1919; 1930); and from India (Menon, 1930; Rao, 1931); showing a world wide distribution within the warm belt.

All Atlantic records undoubtedly belong to *T. haplonema*. And so far as can be judged from available information, all Indo-Pacific Tamoyas so far reported also represent a single species. But it is still an open question whether or not the Atlantic and Indo-Pacific forms are distinct. If so, the correct name for the Indo-Pacific species is *gargantua*, for the earliest named Indo-Pacific carybdeid that is definitely proved, by the description, to have been a *Tamoya*, is the *T. gargantua* of Haeckel (1880), for which he revived a name under which Lesson (1830) had long before reported a large carybdeid from New Guinea. And while neither Lesson's account, nor his illustration, gave any indication of the details needed to show whether his specimen was actually a *Tamoya*, or a large *Carybdea*, stability of nomenclature will be served by following Haeckel in this regard. Should the Atlantic and Pacific Tamoyas be finally united, *haplonema* would become a synonym of *gargantua*.

Reasons are given above for abandoning altogether the specific name *bursaria* which Haeckel (1880) substituted for Lesson's *Bursarius cytherae*, on the assumption that it also was a *Tamoya*.

Tamoya haplonema Müller.

Tamoya haplonema, Müller, 1858, p. 1, Pl. 1, 2; L. Agassiz, 1862, p. 174; Haeckel, 1880, p. 443; Brooks, 1882, p. 138; Von Lendenfeld, 1884, p. 245; Mayer, 1904, p. 28, Pl. 7, Figs. 60-64; 1910, p. 513, Pl. 57, Fig. 2; Stiasny, 1934, p. 339.

Tamoya prismatica, Haeckel, 1880, p. 443.

Charybdea (Tamoya) haplonema, Fewkes, 1889, p. 526.

Non *Tamoya haplonema*, Boone, 1933, p. 39, Pl. 6.

Material: Surface, June 25, 1929, 1 specimen, heighth about 70 mm., breadth about 45-50 mm. (depending on the degree of flattening), length of pedalia along inner edge, about 22 mm., of fin-like expansion of latter, 15 mm., heighth of rhopalia above bell margin, 13 mm.

Although the Atlantic species of *Tamoya* has been mentioned repeatedly, by name, in the literature of medusae, few students have been fortunate enough to have seen specimens of it. First described by Müller (1858), it was next reported by Haeckel (1880) whose description (as "*T. prismatica*") of a West Indian specimen agreed so closely with the original account, both in arrangement of phacellae, in size of stomach, and in complexity of velar canals, as to make it certain that he was dealing with *haplonema*. As the next reports were by name only (Brooks, 1882; Fewkes, 1889), it is possible that they may actually have referred to some *Carybdea*. And the "*T. haplonema*" recorded from the Bahamas by Boone (1933, p. 39, Pl. 6) seem certainly to have been *Carybdea* (probably *C. xaymacana*), for her illustration shows a very flat stomach, with brush-like groups of phacellae at its corners.

Mayer (1904; 1910), however, had typical examples of *T. haplonema*, as had Stiasny (1934) more recently.

The single Bermudian specimen (considerably crumpled) agrees so

[20] Omitting references by name only.

closely in general form with Mayer's (1910, Pl. 57, Fig. 2) picture that illustration is not required.

In the preserved condition, the gelatinous substance is stiffer than in any other carybdeid I have seen. And the nematocyst warts described by previous students (see particularly, Stiasny, 1934) are still to be seen thickly strewn here and there on the exumbrella down to the bell margin, likewise on the outer faces of the pedalia, though the surface has been so badly rubbed that nothing can be said as to the regularity of their distribution. As the size of the stomach is a distinctive feature of the genus, I may note that this organ (Text-fig. 17) is about as long as shown by Müller (1858, Pl. 1, Fig. 1) and by Mayer (1910, Pl. 57, Fig. 2), i.e., with lips hanging to about the mid-level of the bell; this is somewhat shorter than in Stiasny's (1934) West African specimen—a difference perhaps due to the degree of contraction. The well differentiated, pointed lips are also much as pictured by Müller and by Stiasny. They are not shown clearly by Mayer (1910, Pl. 57, Fig. 2).
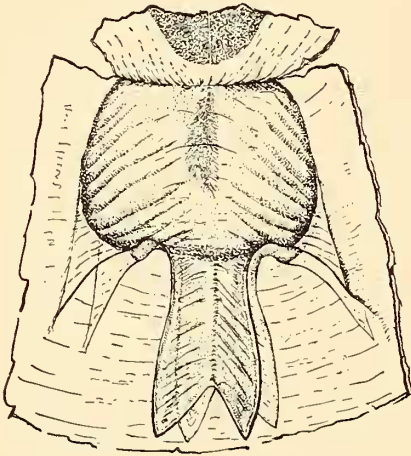
Text-fig. 17.

Tamoya haplonema. Dissection of upper part of bell of Bermudian specimen, to show outlines of stomach, lips, mesenteries, and area occupied by the phacellae. Somewhat schematic.

Mesenteries: Previous statements regarding mesenteries in *Tamoya* have been conflicting. According to Müller (1858) and to Haeckel (1880), the pendulous stomach is bound to the subumbrella by well developed mesenteries in the radii of the rhopalia, as Uchida (1929) also found for the Pacific *Tamoya*. Stiasny (1919, Fig. 6; 1934, Fig. 1), however, pictures the mesenteries as in the radii of the tentacles; while Mayer (1910, p. 512) states that the "so-called mesenteries . . . are merely the flattened perradial sides of the cruciform stomach."

It is therefore worth mention that the Bermudian specimen confirms early accounts, in the presence of mesenteries (Text-fig. 17), and that the latter are in the radii of the rhopalia (perradial). Structurally, they are thin, transparent plates (apparently ectodermic), their free margin crescentic, and by connecting the 4 sides of the stomach with the exumbrella, they subdivide the upper part of the bell cavity into as many blind pockets.

Phacellae: The gastric cirri agree with previous accounts, in being grouped in 4 bands extending vertically along the sides of the stomach, alternating with the lips, i.e., in the radii of the tentacles (thus interradial, as is also the case in *Carybdea*). In Stiasny's (1934) illustration, these bands are shown extending as far as the distal end of of the dilated portion of the manubrium. In the present example, however, they reach only about

P

Text-fig. 19.

Tamoya haplonema. One of the primary trunks with terminal filaments, from the group illustrated in Text-fig. 18. x about 18.

Text-fig. 18.

Tamoya haplonema. One of the groups of gastric filaments of the Bermudian specimen. **P.,** Proximal end. x about 10.

to the mid-level of the latter (Text-fig. 17). As no detailed account has previously appeared, I should add that each group consists of a single row of about 40 primary trunks, arranged (but somewhat irregularly) in a single row, and each dividing, close to its base into several filaments (Text-figs. 18, 19).

Rhopalar Nitches: Earlier accounts (Müller, 1858, Pl. 1, Fig. 1; Stiasny, 1919, p. 39, Fig. 7; 1934, p. 341, Fig. 1B; Uchida, 1929, Fig. 81B) had already shown that the shape of the rhopalar nitches is one of the minor characters separating *Tamoya* from *Carybdea*. In *T. haplonema* (and in its Pacific relative also), the nitches, situated on well marked, ovoid gelatinous prominences of the exumbrella (Text-figs. 20, 21), are continuously bounded, on the lower side as well as on the upper, by a rounded covering-scale, which gives the nitch a pit-like confirmation, very different in appearance, from the more open nitches of *Carybdea* (cf. Text-fig. 20, with Text-figs. 10, 11).

The edges of the marginal pouches, where they enclose the nitches, and for some distance beyond, are strongly lobate (Text-fig. 20); in *Carybdea* (Text-fig. 10), they are smooth.
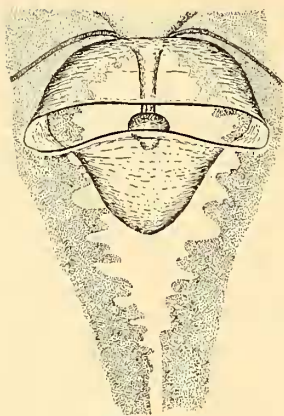
Text-fig. 20.

Tamoya haplonema. One of
the sensory nitches of
the Bermudian speci-
men, to show covering
scales and lobate outlines
of the marginal pouches.
x about 7.
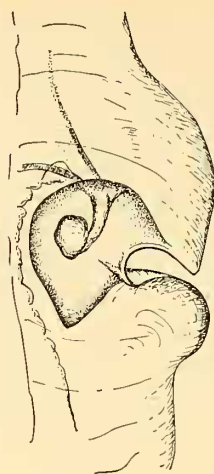
Text-fig. 21.

Tamoya haplonema. Lateral
view of sensory nitch. x
about 6.
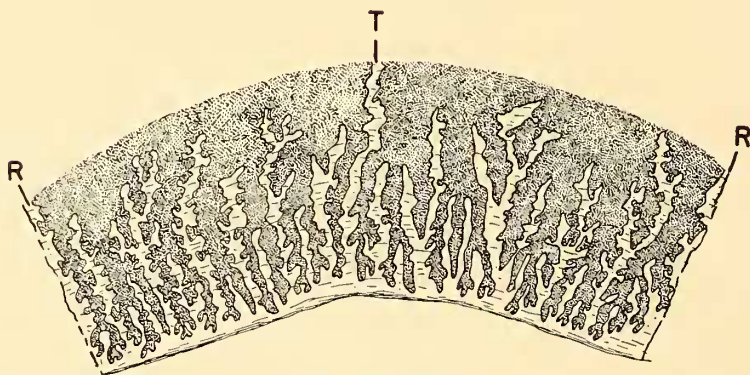
Text-fig. 22.

Tamoya haplonema. One quadrant of velarium of Bermudian
specimen to show velar canals. **T.,** Tentacular radius; **R.,**
Rhopalar radius.

Canals: The readiest field-mark to distinguish *Tamoya* from any *Caryb-
dea* yet described is the lobing of the margins of its complexly forked velar
canals (Text-fig. 22); this type of branching was long ago pictured by
Müller (1858); more recently by Stiasny (1919, Figs. 8, 9; 1934, Fig. 1, C),
and by Uchida (1929, Fig. 85).[21] Previous authors (Mayer, 1910; Stiasny,
1934) record 10 canals per quadrant for *T. haplonema.* In the Bermudian
specimen, the number is less regular, there being only 3 primary canals in
one octant (between tentacular and rhopalial radii); but so complexly sub-
divided that there are 33 terminal branches, whereas in the adjacent quad-

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[21] Mayer's (1910, Pl. 57, Fig. 2) picture suggests a somewhat different type of subdivision, but
it is evidently diagrammatic.

rant, the number of major trunks is 7 (some of which may have been derived by subdivision close to the base) with 30 terminal branches.

Pedalia: These (Text-fig. 23) are intermediate in outline between those figured by Mayer (1910, Pl. 57, Fig. 2) and by Stiasny (1934, Fig. 1a). According to Mayer's figure, the tentacular canals are widely dilated at the distal ends of the pedalia, whereas Stiasny shows them as of uniform bore. Here, again, the present specimen is intermediate, the canals showing only slight dilation distally, but with an irregularity of the margins suggesting that when the pedalia are relaxed, the dilation might be greater.
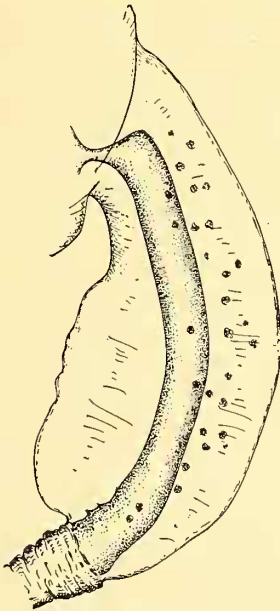
Text-fig. 23.
Tamoya haplonema. Basal part of tentacle. x about 2.

Gonads: These organs are somewhat farther advanced in development than those pictured by Mayer, not only reaching about to the level of the points of origin of the tentacular canals, but so broad that their free edges overlap slightly. In their present state, they are folded, but so irregularly as to suggest the effects of preservation.

General Distribution: Previous records of *T. haplonema* include Brazil (the type locality); West Indies; east coast of the United States, north to Latitude about 41° N., and to the offing of the French Congo.

Periphylla.

Periphylla hyacinthina Steenstrup.

For early synonymy, see Mayer, 1910, p. 544, 546 (*"P. hyacinthina"* and *"P. hyacinthina* forma *regina"*).

For subsequent discussions, see especially Broch, 1913, p. 4; Stiasny, 1934, p. 342.

Material: Net Nos. 13, 16, 17, 23, 26, 33, 34, 39, 43, 44, 45, 53, 83, 88, 89, 100, 103, 114, 116, 119, 121, 135, 141, 142, 144, 145, 154, 157, 178, 196, 221, 234, 235, 240, 241, 261, 267, 269, 270, 273, 274, 278, 279, 280,

291, 292, 293, 295, 296, 405, 434, 449, 543, 545, 546, 547, 548, 551, 552, 555, 562, 577, 581, 590, 595, 618, 619, 620, 621, 624, 625, 626, 631, 638, 644, 645, 646, 654, 674, 686, 688, 692, 699, 707, 709, 710, 712, 716, 721, 722, 723, 724, 726, 728, 730, 731, 732, 734, 736, 746, 750, 752, 756, 758, 759, 762, 766, 767, 772, 773, 774, 775, 778, 780, 785, 791, 795, 796, 797, 798, 799, 801, 804, 809, 818, 822, 825, 827, 832, 835, 836, 837, 838, 842, 846, 848, 850, 851, 852, 854, 855, 858, 860, 880, 882, 883, 885, 886, 895, 896, 898, 905, 916, 917, 918, 921, 925, 928, 930, 932, 933, 935, 937, 939, 940, 951, 963, 970; 317 specimens; 1-14 (in most cases, 1-3) per haul.

Successive studies (see especially Stiasny, 1934) have now definitely established that the two representatives of this genus most often reported —*dodecabostrycha* and *hyacinthina*—are nothing more than· growth stages, contraction phases, or color variants of one species; and that this probably is equally true of the third, *regina*. Stiasny (1934, 1937), on the basis of the *Discovery* collection, has concluded that the three represent successive stages in growth, the *dodecabostrycha* form (small, with low rounded stomach and transparent peripheral zone) being the youngest, the *hyacinthina* form (with peripheral entodermal system also pigmented, and usually with high, pointed stomach), an intermediate stage—usually 75-80 mm. in diameter— while the *regina* form represents the largest, usually more than 80 mm. in diameter, with extensive and dense peripheral pigmentation, but again usually low-domed, as are the juveniles.

The Bermudian series (many of which are in excellent condition) corroborates this general growth relationship, so far as the *dodecabostrycha* and *hyacinthina* types of pigmentation are concerned, for among 38 small specimens taken at random, 5-12 mm. in diameter at the level of the coronal furrow, 37 have the peripheral zone so hyaline that the gonads are entirely visible, only one being so densely pigmented that they are concealed. Among 37 specimens of 15-20 mm. the gonads are completely visible in only 21; their upper portions are obscured by the spreading pigment in 7; and completely so obscured (*hyacinthina* form) in 9. And among 27 specimens of 25-40 mm., the gonads are entirely obscured in 18; partially so in 8; and completely visible only in 1. However, still larger specimens occasionally retain the restricted ("*dodecabostrycha*") type of pigmentation; this being true of one Bermudian example of 45 mm.; and of another of 55 mm. The series does not include any specimens larger than 60 mm., hence, throws no additional light on the *regina* form.

It seems that the very smallest specimens (smaller, say, than 8-9 mm. in diameter at the coronal furrow) usually, or always, have the gastric floor low-domed. It is already more or less definitely conical, however, in the majority of the Bermudian specimens of 10-12 mm., in several cases pronouncedly so (extreme *hyacinthina* type). It has already been sufficiently emphasized, by various students, that medium-sized specimens show wide variation in this respect, with complete integradation from the lowest and rounded, to the highest and most acutely conical—depending, I believe, entirely on phases of contraction.

Broch (1913, p. 7) and Stiasny (1934, p. 356) have both observed that the apical projection of the aboral gastric wall into the mesoglea, so often observed in *Periphylla* and frequently referred to as a "stiel canal," does not occur in very small specimens. This the Bermudian series corroborates, for while the gastric apex is acutely conical in some, even of the smaller (down to 11 mm. in diameter at the level of the coronal furrow), the smallest in which the apex shows anything that could be named a canalar elongation is about 17 mm. in diameter. We can, then, finally conclude that this struc-

ture has nothing whatever to do with a true stiel canal—i.e., does not indicate derivation from a Scyphistoma stage, but merely represents one extreme in the phases of contraction that govern the contour of the floor of the stomach in middle-sized individuals.

It is interesting that, in *Periphylla* (as in *Atolla*, p. 161), the gonads appear while the medusa is still not more than 5-8 mm. in diameter at the level of the coronal furrow[22]. By the time a diameter of 15-20 mm. is reached, the sexual organs may be proportionately about as large as they are in large specimens, the females with large eggs. But we have still to learn through how extensive a growth-phase any individual specimen may actually set free its sexual produce.

General Distribution: Enough records have now accumulated to prove that *Periphylla* is truly cosmopolitan in seas of appropriate depth and temperature[23], Atlantic, Pacific, and Indian, right up to the polar fronts. Having been already taken in the Straits of Florida (Bigelow, 1918), and to the southeast of Bermuda (Bigelow, 1928), it was a foregone conclusion that any campaign of deep towing would yield it in the immediate vicinity of the latter.

Seasonal and Annual Distribution: The following tabulation of the percentage of the hauls, at 732-0 meters or deeper, that took *Periphylla* (the number taken shoaler was negligible) illustrates the relative frequency of occurrence, in different months, and as between the two years 1929 and 1930:

	1929				1930		
Months.	Total Hauls.	Hauls with *P.*	% with *P.*	Months.	Total Hauls	Hauls. with *P.*	% with *P.*
April	47	13	29	April	......	......	......
May	75	15	20	May	87	26	30
June	93	9	9	June	82	23	28
July	107	14	13	July	52	23	44
Aug.	51	0	0	Aug.	11	1	9
Sept.	106	3	3	Sept.	136	43	31

Thus it appears that *Periphylla*—like *Atolla* (p. 163)—occurred with much greater frequency in 1930 than in 1929. But the annual difference in actual abundance was not as great for *Periphylla* (180 specimens in 343 deep hauls, or 0.5 per haul in 1930; 127 specimens in 462 deep hauls, or 0.3 per haul in 1929) as for *Atolla* (p. 162). And the data for the two years agree in showing the greatest frequency in spring and early summer, with a decided decrease in late summer, followed by some recovery in early autumn, especially in 1930.

The 95 hauls that yielded juveniles of 15 mm. or smaller, were well distributed through the season, most numerous and in roughly comparable numbers (17-23) for May, July and September, evidence that *Periphylla*, near Bermuda, reproduces throughout the spring and summer. Probably it does so throughout the year there, as Kramp (1924) found to be the case in the Mediterranean.

Vertical Range: No *Periphylla* were caught in hauls from 366-0 meters or shoaler. The distribution of the catches in both years combined, in the deeper hauls, was as follows:

[22] The smallest individuals are in poor condition, but gonads are visible in several not more than 5 mm. in diameter, though still very small.

[23] It is not likely that it will ever be found in the Red Sea, for example.

Depth in Meters.	No. of Hauls Made.	No. of Specimens.	Av. No. Specimens per Haul.
366-0	12	0	0.0
549-0	23	2	0.08
732-0	40	4	0.1
914-0	132	53	0.4
1,097-0	134	85	0.6
1,280-0	132	29	0.2
1,463-0	135	28	0.2
1,646-0	135	60	0.4
1,829-0	135	48	0.4
2,012-0	4	2	0.5

From the foregoing, it appears that in the region in question, *Periphylla* regularly lives only deeper than about 600 meters and has its chief abundance considerably deeper (from about 900 meters downward) than in the Mediterranean, or off the coast of Spain and Portugal where the *Thor* (Kramp, 1924) found it most numerous in hauls from about 150-200 to 600-700 meters[24], while one Mediterranean catch was made close to the surface. Farther north in the Atlantic, also, the upper limit to its most frequent occurrence was found to be between about 250 and 500 meters (occasional specimens as shoal as 50 meters) along the route of the *Michael Sars* Expedition (Broch, 1913); in the Sognefjord, Broch (1913) reports it as numerous as shoal as 150 meters—again with its upper limit a little above 50 meters. And in west Greenland waters the *Ingolf* found it about equally frequently at one level as at another, right up to the surface (Kramp, 1913). In high southern latitudes, also, *Periphylla* has been taken, not only in deep hauls, but in the superficial stratum, and at the surface as well, on several occasions (Browne, 1910; Stiasny, 1934, Table, p. 364, 365). The combined picture is thus of a species strictly bathypelagic throughout most of its range, but with the upper limit to its normal occurrence lying at a progressively higher level, toward high latitudes, until, in subpolar seas, it comes right up to the surface. Stiasny's (1934) observations show, too, that in upwelling regions it may frequently be brought up to the superficial strata, as well as casually elsewhere, as noted above.

So far as is yet known, it is in the Sargasso Sea region (typified by the vicinity of Bermuda) that the upper boundary to its regular occurrence lies deepest, at least for the Atlantic. On the basis of these data, it seems likely that the upper boundary for *Periphylla* is set by light combined with temperature. As to the latter, one can at least say that water of 12°-13° is not unfavorably warm for it, witness its regular occurrence in the deeps of the Mediterranean (Kramp, 1924). But, so far as I have been able to learn, it has never been found, more than casually, in temperatures much higher than that.

Recorded captures do not suggest any definite lower limit; like sundry siphonophores (Bigelow and Sears, 1937), however—and perhaps the majority of bathypelagic animals—its numbers decrease as truly abyssal depths are reached.

Segregation by sizes shows that the upper zone of concentration, near the 1,000-1,200 meter level, represents the zone of greatest abundance of juveniles, the depth distribution of specimens of 15 mm., or smaller, being as follows:

[24] Kramp (1924) estimates the depths of the *Thor* hauls as equalling about one-half the length of wire out. But it seems likely, from Jespersen's (1915) experiments, that the towing depths were actually somewhat greater, with 2/3 the wire length as perhaps maximal (Bigelow and Sears, 1937, p. 73).

Depth in Meters.	Number Juveniles.	Depth in Meters.	Number Juveniles.
366-0	0	1,463-0	6
549-0	4	1,646-0	18
914-0	41	1,829-0	8
1,097-0	44	2,012-0	1
1,280-0	9	2,195-0	1

The largest individuals were even more definitely concentrated in the deepest strata—responsible in part for the apparent concentration at the 1,400-1,800 meter level—for out of the 16 specimens, of 35 mm. or larger, 7 were from 1,646-0 meters[25], 8 from 1,829-0 meters, one only from a shoaler haul (549-0 meters).

It is especially interesting that in West Greenland waters, Kramp (1913) found juveniles most abundant at about 600-700 meters[26], i.e., but little shoaler than at Bermuda. This perhaps indicates that *Periphylla* is not permanently endemic in the Arctic water of the Greenland-Labrador sea region, but that the supply there is maintained by the deep indraft of Atlantic water, a hydrologic phenomenon now well recognized.

NAUSITHOIDAE.

Nausithoe.

Nausithoe punctata Kölliker.

Nausithoe punctata, Kölliker, 1853, p. 323.

For synonymy, see Bigelow, 1909, p. 35; 1928, p. 498; Mayer, 1910, p. 554; Thiel, 1928, p. 25.

Material: Net No. 627, 1,097-0 meters, May 23, 1930, 1 specimen.

Net No. 719, 1,280-0 meters, June 25, 1930, 2 specimens.

Net No. 773, 1,829-0 meters, July 4, 1930, 1 specimen.

Net No. 793, 1,280-0 meters, July 9, 1930, 1 specimen.

Net No. 967, 914-0 meters, September 30, 1930, 1 specimen.

The specimens, ranging from 5 to 9 mm. in diameter, are specifically recognizable, though fragmentary; one alone (Net No. 793) still shows the characteristic dark-pigmented ocellus on one of the rhopalia.

Earlier accounts have credited *N. punctata* with spherical gonads, as has been true of the specimens of it from the eastern tropical Pacific, from Japanese waters, from the Mediterranean, and from Florida and the West Indies that I have previously examined; likewise of the specimen from Net No. 793 (a ♀ with eggs of various sizes). A specimen from Net No. 719 and one from Net No. 967 seem at first sight to have horse-shoe shaped gonads, with concavities directed centripetally. But it appears from more careful examination that the pockets (globular in life) within which the sex products are developed, had been torn open on the centripetal sides by the rough treatment the specimens had received, correspondingly disrupting the sexual tissue still adhering to their inner walls. That is to say, their present resemblance to the horse-shoe shaped gonads pictured by Haeckel (1879, Pl. 27), for his genera, *Ephyra* and *Palephyra*[27], is purely accidental.

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[25] This tends to corroborate Stiasny's (1934, p. 363) conclusion that, during its development, it tends to move slowly into the deeper layers.

[26] Recorded at 1,000 meters of wire out.

[27] In Vanhöffen's (1902, Pl. 3, Fig. 10) illustration of *Palephyra indica*, they are kidney-shaped.

This being a neritic species, it is likely that the specimens here listed were the product of the Bermudian Bank. To find *N. punctata* a few miles out from the land is no surprise, for it has long been known that the free-living stage of *N. punctata* endures long enough for it to drift much greater distances. It had not been recorded previously from Bermudian waters, but was to be expected there, for it is common in the West Indies (Mayer, 1910), as well as widespread in warm seas generally. See Mayer (1910, p. 555), for a summary of the earlier accounts of its developmental stages.

As the attached stage is known to be commensal within certain sponges of the littoral zone, and as adults have commonly been taken close to the surface elsewhere, it is somewhat astonishing that the Bermudian specimens were all from deep hauls. But the numbers concerned are so small that no estimation is possible of the actual depths of capture.

ATOLLIDAE.

Atolla.

Atolla wyvillei Haeckel.

Atolla wyvillei, Haeckel, 1880, p. 488; 1881, p. 113, Pl. 29, Figs. 1-9.

For early synonymy, see Mayer, 1910, p. 563, 565, 567 (*"A. bairdii"* + *"A. valdiviae"* + *"A. gigantea"* + *"A. wyvillei"*).

For subsequent discussions of relationships, see especially Broch (1913, p. 13), Browne (1916, p. 203), Bigelow (1928, p. 505), and Stiasny (1934, p. 365.).

Material: Net Nos. 23, 26, 29, 36, 39, 41, 53, 62, 66, 74, 78, 100, 102, 105, 111, 118, 122, 142, 154, 196, 221, 240, 247, 253, 292, 293, 295, 296, 368, 434, 539, 544, 545, 546, 552, 553, 556, 561, 562, 563, 565, 568, 574, 575, 582, 588, 596, 597, 598, 599, 601, 605, 606, 611, 618, 619, 625, 626, 631, 632, 633, 637, 639, 647, 648, 652, 657, 659, 666, 674, 676, 681, 682, 685, 687, 688, 691, 698, 701, 707, 719, 720, 721, 727, 739, 741, 745, 748, 767, 770, 774, 777, 778, 781, 787, 789, 798, 799, 800, 801, 804, 806, 808, 810, 812, 824, 826, 829, 831, 838, 846, 850, 860, 861, 863, 865, 875, 881, 882, 885, 892, 917, 926, 928, 937, 938, 943, 964; 549-0 to 1,829-0 meters; 232 specimens, 1-6 per haul, except for Net Nos. 565, 707, and 767, which captured 10, 8, and 9 specimens respectively. The specimens range from 7 to 100 mm. in diameter.

It now seems so thoroughly established that all known Atollas, that have smooth marginal lappets, belong to the one species *wyvillei*, that this viewpoint needs no further defence (see Kramp, 1924; Bigelow, 1928; and Stiasny, 1934, for recent pronouncements on this subject). Stiasny (1934, p. 366) has thought it possible from his study of the extensive *Discovery* series to divide the comprehensive species *wyvillei* into three forms, according as the margin of the central disc is indented with broad radial notches (*wyvillei* form), or with narrow notches (*verrillii* form), or is entirely smooth (*bairdii* form), Conditions, however, in the Bermuda series and in the others I have studied suggest that these differences (so far studied only in preserved material), like the relative prominence of the annular zone, chiefly reflect the state of contraction, or relaxation of the animal when preserved. But individual variation may also enter into the case, to a degree that it is not yet possible to estimate. Certainly, we do not have to do with geographic variation, for the *Arcturus* and *Discovery* collections have already shown that it is not unusual for narrow-notched, broad-notched, and smooth disced individuals to be taken side by side in the same haul. In a given individual some of the notches may, furthermore, be broad, others narrow (Bigelow, 1909, p. 40); and it frequently happens that a

given individual may be equally well characterized as "broad-notched," or as "narrow," there being a complete inter-graduation between the two. The Bermuda collection now contributes at least one specimen (Net No. 221) about 65 mm. in diameter, in which the margin of the disc is entirely smooth on one side, but shows clear traces of broad notches on the other.

Recent collections have yielded the smooth and notched or furrowed forms in varying proportions, the relative counts being 112 notched (*verrillii, wyvillei*), and 92 smooth (*bairdii*), for the *Discovery* series (Stiasny, 1934, p. 370), 12 notched to 3 smooth, for the *Thor* series (Kramp, 1924), and 103 smooth (or nearly so) to 57 furrowed, for the *Michael Sars* collection (Broch, 1913). Among such of the Bermuda series as are in good enough condition to be significant in this respect, there are 25 smooth to 38 with the margin of the disc variously notched.

Previous collections had shown that in specimens upwards of, say, 30 mm. in total diameter, i.e., presumably with the final number of tentacles, there may be as many as 29 or as few as 14 of these; the majority of large specimens having from 22 to 28 (see Vanhöffen, 1902, Bigelow, 1909, and Kramp, 1924, for tabulations of tentacle numbers at different sizes). Eighteen to twenty-two tentacles have already been recorded in small specimens 8-10 mm. in diameter (Vanhöffen, 1902; Kramp, 1924). Among the smallest of the Bermudian specimens, of 7-12 mm., the tentacle number ranges from 19 to 24, most frequently 20, the smallest specimen (7 mm.) having the latter number.

The most interesting contribution by the Bermudian series to knowledge of *Atolla* is its confirmation of earlier observations (Maas, 1897; 1904, Vanhöffen, 1902) that the gonads regularly appear while the medusa is still very small, for these organs are already of moderate size in 11 out of 14 specimens of 7-9 mm., while all but two out of the 54 specimens of 15 mm. or smaller, that are in good enough condition for study, have gonads. And eggs of various sizes are clearly visible in one specimen of only 10 mm., in two of 11 mm., in one of 13 mm. and in one of 14 mm. But it seems that in occasional specimens these organs may not develop until much later, for in one of 30 mm., the gonads are still very small. At the other extreme, Maas (1904) has reported a 72 mm. *Atolla* as spent. Even the largest, however, of the Bermudian specimens, from 60-100 mm. in diameter, still have full, or partly full gonads, both sexes being represented.

In short, it appears that *Atolla*—like *Periphylla*—is sexually active throughout most of the growth period. But nothing is yet known as to how long, in point of time, this latter may continue.

Broch (1913) has argued, from the depth distribution of the extensive series collected by the *Michael Sars* in the North Atlantic, that the wide variations that occur in the characteristic pigmentation of *Atolla* are correlated with the depths at which given specimens live, those in which only the stomach is densely pigmented (Broch's group I) having been taken most numerously in hauls from 500 meters, those with more extensive pigmentation in hauls from 750 and 1,000 meters. Stiasny (1934) likewise found the *Discovery* captures at least compatible with this, except in the Antarctic and in the upwelling waters off West Africa. Unfortunately, the Bermudian series throws little light on this point, partly because the great majority of the hauls sampled the water to a depth of 900 meters or more, and partly, because the great majority of the specimens were so much rubbed in the nets, that it is impossible to tell how extensive their pigmentation was in life. The most that can be said is that 14 of the 16 specimens in which the ring muscle is strongly pigmented (or apparently was so in life), were from hauls from 1,097-0 meters, or deeper, whereas the genus was of most frequent occurrence in the 914-0 meter hauls, as noted below. But it is not safe to estimate the vertical distribution of the contrasting specimens in

which the pigment is now confined to the stomach (Broch's group I), because many of these still show some slight trace of peripheral pigment, as well.

General Distribution: *A. wyvillei* has already been reported close to Bermuda (Bigelow, 1928, p. 509), as well as at many other localities widespread in the North Atlantic from side to side; it is in fact now known to be one of the most cosmopolitan of bathypelagic medusae, to be expected anywhere in the basins of the open oceans. But like some other bathypelagic forms, it seems to be barred from access to the Mediterranean (Kramp, 1924; Bigelow and Sears, 1937).

To the northward, it has been taken to Lat. 64° N. in the western side of the Atlantic, north of the Faroe-Shetland ridge in the eastern (Kramp, 1914; Broch, 1913), to Bering Sea in the Pacific (Bigelow, 1913). To the southward, its recorded range extends right down to the Antarctic, namely to Lat. 63° S. in the Indian Ocean (Vanhöffen, 1902): to 68° S. in the Atlantic (Stiasny, 1934), to 70° 30′ S. in the Pacific (Browne, 1910).

Seasonal Distribution: In 1930, *Atolla* was taken rather regularly right through the collecting season, from early May until late September.   In 1929, however, when it occurred regularly from April through July, only one was taken in August, only 6 (in one net haul) in September, although 169 hauls to suitable depths (500-0 meters) were made during those two months.   Similarly, the total number taken was only about ⅓ as great in 1929 (54 specimens) as in 1930 (171 specimens) although many more hauls were made to 900-0 meters or deeper, in the former year (462 hauls) than in the latter (343 hauls).   In our present ignorance of the ecological relationships of this species, any attempt to explain this annual difference in its abundance would be pure guesswork.   As elsewhere emphasized (Bigelow, 1918, p. 509) winter towing, in the Cape Hatteras-Bermuda-Bahamas triangle, did not yield it at all. But the interpretation of this seasonal periodicity must await a knowledge of whether it passes through a fixed stage in its development, or whether it is holoplanktonic as seems the more likely from its bathymetric range.

In 1929, so few very small specimens (of 12 mm. or less) were taken (3 in April, 1 in May, 1 in July, 1 in August) that no weight can be given to their seasonal distribution. In 1930, however, there was an unmistakable concentration of young stages in spring and autumn (24 were taken in May, 6 in June, 11 in September) contrasting with the comparative scarcity in July (5) and August (1).   A combination of the data for the two years yields the picture of a species breeding at least from mid-spring to early August, but with a definite slackening of production in the late summer.

Vertical Range: The distribution of the specimens according to the depth of haul is as follows:

Depth in Meters.	No. of Specimens.	No. of Hauls.	Specimens. per Haul.
366-0	0	12	0.0
549-0	2	23	0.09
732-0	3	40	0.08
914-0	56	133	0.42
1,097-0	41	134	0.3
1,280-0	38	132	0.3
1,463-0	42	132	0.3
1,646-0	32	135	0.2
1,829-0	14	135	0.1
1,829-0	0	5	0.0

This indication of an upper limit not far from 500 meters, and of a preponderance between 1,000 and—perhaps—1,500 meters, is in line with the catches of the *Michael Sars* farther north in the Atlantic (Broch, 1913).

The catches of very small specimens (of 13 mm. or smaller) show even more definite concentration near the 1,000 meter level, with no indication whatever of any tendency on the part of the juveniles to live at any higher level in the water than do the adults; data are as follows:

Depth in Meters.	No. of Specimens.	No. of Hauls.	Specimens per Haul.
366-0	0	12	0.0
549-0	0	23	0.0
732-0	1	40	0.02
914-0	27	133	0.20
1,097-0	8	134	0.06
1,280-0	8	132	0.06
1,463-0	5	132	0.04
1,646-0	6	135	0.05
1,829-0	2	135	0.02

There is, however, some indication that as Atollas attain their full size they tend to sink, for no specimens of 50 mm. or larger were taken as shoal as 732-0 meters, only one from 914-0 meters, 3 at 1,097-0 meters, 2 at 1,280-0 meters, 7 at 1,463-0 meters, 6 at 1,646-0 meters (a preponderance at, say, 1,400 meters or deeper), and one at 1,829-0 meters.

LINUCHIDAE.

Linuche.

Linuche unguiculata Schwartz.

Medusa unguiculata, Schwartz, 1788, p. 195, Pl. 6, Fig. 1.

For synonymy, see Mayer, 1910, p. 558 (*"L. unguiculata"*), p. 560 (*"L. aquila"*); Vanhöffen, 1913, p. 429; Bigelow, 1928, p. 510; Stiasny, 1931, p. 30, 1935, p. 13; Darby, 1933, p. 268.

Material: Dip-net, surface, June 8, 1929, hundreds of specimens, about 1.5 mm. in diameter.

Dip-net, surface, July 23, 1929, 1 specimen, 5 mm. in diameter.

Net No. 293, 1,280-0 meters, July 12, 1930, 1 specimen, 6.5 mm. in diameter.

Net No. 690, 2,012-0 meters, June 9, 1930, 2 specimens, 4.5-11 mm. in diameter.

Net No. 694, 1,646-0 meters, June 12, 1930, 1 specimen, 5.5 mm. in diameter.

Reasons are given in an earlier paper (Bigelow, 1928) for including, under the old name *unguiculata*, the form *aquila*, first described by Haeckel (1880), which has at various times been regarded as a distinct Pacific species, or as a variety sufficiently well marked to deserve recognition in nomenclature. And this union has subsequently been accepted by Stiasny (1931).

Thiel (1928) has argued that *L. draco* Haeckel is a distinct species, separated from *unguiculata* by its large size (up to 20 mm. in diameter), by the arrangement of the subumbral pockets in two series, by the number

(48) of horse-shoe shaped gonads, and by green color (due to the infesting zooxanthellae). It is doubtful, however, whether these distinctions will stand the test of time. Size, in particular, is hardly likely to prove of specific significance. At most, a large variety might be indicated—whether regional, or seasonal—or representing the growth of the members of a particular brood under specially favorable surroundings. So far as the number of pockets and their arrangement is concerned, I may point out that while it is usual in typical *unguiculata* for these to be in 3 rows, 32 in the outer, 16 in the median, 4-8 in the inner, an occasional large specimen (12 mm.) may lack the inner row entirely. And the number in the intermediate row may even be as small as 8, reducing the total number to 40 (Bigelow, 1928, p. 512, Fig. 184). It has also been found in typical *unguiculata* that, while the gonads originate in pairs, the members of each pair may, with growth, either "come together in the perradii, resulting in four horse-shoe shaped figures" (Bigelow, 1928, p. 513, Fig. 184); i.e., attain the *"draco"* condition, or may still continue separate until the medusa is well grown (Bigelow, 1928, p. 513, Fig. 183).

Nor does color seem any more likely to prove an alternative character, Darby (1933) having recently found that *L. unguiculata,* at the Tortugas, contains 2 pigments[28], which—depending on the degree of oxidation—give the subumbrella a yellowish brown color by day (the usual *unguiculata* color), but a spotted dark green pattern by night, i.e., the *"draco"* hue. In short, it now seems probable that specimens having the *"draco"* characteristics, represent variants of *unguiculata,* though we are still entirely in the dark, as what conditions—seasonal, environmental, or genetic—favor their appearance.

General Distribution: Previous records for the general region of Bermuda (Fewkes, 1883; Bigelow, 1928) had already made it likely that the Bermuda Bank is a center of production for *Linuche,* the farthest extra-tropical such center in the Atlantic. And this is corroborated by the catch of juveniles, listed above.

Vertical Range: *Linuche* commonly swarms at the surface. The few specimens listed above from deep hauls were probably picked up by the nets on their way down or up.

DISCOPHORA.

PELAGIDAE.

Pelagia.

Pelagia noctiluca Forskål.

Medusa noctiluca, Forskål, 1775, p. 109.

For synonymy, see Mayer, 1910, p. 572-576 ("*P. noctiluca,*" "*P. noctiluca* var. *neglecta,*" "*P. cyanella,*" "*P. panopyra,*" "*P. panopyra* var. *placenta,*" "*P. flaveola,*" "*P. perla,*" "*P. phosphora,*" "*P. crassa,*"); Stiasny, 1914, p. 529, p. 531 ("*P. purpuroviolacea*" and "*P. rosea*"); 1924, p. 83 ("*P. curaçaoensis*").

Material: Net No. 863, 1,646-0 meters, September 8, 1930, 1 specimen, about 26 mm. in diameter.

Surface, September 12, 1930, 1 specimen, about 45 mm. in diameter.

The several authors who have recently studied this wide-ranging and widely varying genus, have successively reduced the number of so-called species. On the basis of the *Arcturus* collection, I concluded that one species of *Pelagia* (*P. noctiluca*), at any rate, "occurs widespread, over the warmer

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[28] Probably these are actually in the contained zooxanthellae.

parts of the Indian and Pacific and Atlantic oceans" (Bigelow, 1928, p. 519) and doubted whether any of the other named forms could be separated from it, specifically. Stiasny (1934, p. 388), in his most recent discussion of the genus, likewise makes equally drastic reduction, writing "there is most probably only a single species of *Pelagia* with a world wide distribution over all tropical and subtropical parts of the ocean." This species must bear the name that was earliest given to a medusa recognizable as *Pelagia*, the *P. noctiluca* of Forskål. Menon (1930) has likewise applied this name, without discussion, to *Pelagia* from the Indian Ocean.

Subsequently, however, Stiasny (1935) has maintained that *flaveola* is also a good species.

Whether any of the other named forms deserve recognition at all, as geographic or environmental races, or whether they merely represent individual or swarm variations, different stages in growth, or contraction phases, is still an open question, the solution of which is not aided by the present small series. I can only point out that, in the larger specimen, linear exumbral warts greatly predominate in the marginal zone, but are intermingled with round-oval warts in nearly equal numbers in the central zone. That is to say, the so-called *perla* and *pelagia* types are combined with the *noctiluca* type (narrow linear warts) on different parts of the bell. Menon (1930) also reports finding both long warts and rounded. This is additional evidence that specific distinctions cannot be based on the shape of these structures.

General Distribution: *Pelagia* was to be expected in the collection, having already been found near Bermuda (Fewkes, 1883; Bigelow, 1928). It is, however, interesting that so large a number of hauls, shoal as well as deep, made in so many different months, should have yielded so few specimens of a species which has now been encountered—often in swarms—at many stations, in the warm belts of all oceans, as well as in the Mediterranean.

Poralia.

? Poralia rufescens Vanhöffen.

Poralia rufescens, Vanhöffen, 1902, p. 41, Pl. 4, Fig. 15, 16; Bigelow, 1909, p. 45, Pl. 13, Figs. 1-5.

Material: Net Nos. 50, 247, and 726; hauls from 1,646-0, 1,829-0, and 1,463-0 meters; fragments of the central parts of 3 specimens; diameters of base of stomach, respectively about 30, about 35, and about 18 mm.

This species is one of the most interesting finds in the collection, for it is only the third record for the genus. *Poralia* was first described by Vanhöffen (1902) for a fragmentary specimen (marginal zone torn off) with very simple gonads consisting of outpocketings projecting direct from the gastric wall into the subumbral cavity, in seven groups of 3 or 4 pockets each. This type of symmetry, as Vanhöffen pointed out, was previously known (for Scyphomedusae) only as an abnormality of *Aurelia*. There were 21 or 22 narrow radial canals.

Two specimens in the *Albatross* collection (Bigelow, 1909), though likewise very fragmentary, allowed some amplification of Vanhöffen's original account. In the smaller, there were 8 groups of sexual folds, and 21 canals in about ½ the circumference, suggesting octoradial arrangement and about twice as many canals as Vanhöffen's example. In the larger and somewhat better preserved *Albatross* specimen, about 250 mm. in diameter, the sexual folds formed a practically continuous ring, surrounding the base of the stomach, but separated by gelatinous pillars, into 18 or 19 groups of 6 or 7 pockets each. And there were 41 canals. As already remarked (Bigelow, 1909, p. 46), a growth series is here indicated, with multiplication of canals,

and of sex folds, accompanied by a corresponding formation of additional pillars.

In the largest Bermudian specimen (so far as can be seen in the present fragmentary state), the sex folds are in five groups, separated by as many broad gelatinous pillars, corresponding to as many angles at the base of the manubrium. The number of folds per group is 5, 5, 6, 5(?), 5, while in most of the groups the larger central folds are flanked in addition by indications of very small folds, which (if they developed) would raise the number per group to 6-8. Several of the folds contain large eggs. But this cannot be taken as proof that the specimen had reached its full growth, for it is equally possible that the development of sex products may extend over a considerable period, allowing opportunity for subdivision of the primary groups of six folds by the development of additional pillars. The number of pillars is also apparently five in the smallest specimen (stomach, 18 mm. in diameter); the condition of the third specimen is too bad for counting.

The canals are very narrow, as in Vanhöffen's example of corresponding size, approximately 38 in number in the smallest specimen, about 40 in the example 30 mm. in diameter of stomach, but only about 30 in number in the largest.

These conditions of metamerism in the Bermudian specimens make it likely, not that *Poralia* is primarily octoradial as I formerly suggested, but that it is primarily quadriradial, but that with the growth of the medusa, the original state is obscured by the formation of additional canals, and by subdivision of the original groups of sex folds through the development of additional gelatinous pillars. Different specimens would then show different numbers of groups of sex folds—as is actually the case—if these developments take place at different rates, in different radial sectors, as may very well happen. Decision whether geographical races of the species exist in this respect, or whether it has been a matter of pure chance that different numerical conditions have been illustrated by the few specimns so far seen from the Indian, Pacific, and Atlantic oceans, must await a study of larger series.

In the Bermudian, as in the *Albatross* examples (Bigelow, 1909, Pl. 13, Figs. 1-3), the gastric cirri are arranged in a single fringe-like row, in as many groups as there are groups of sex folds, there being none on the gelatinous pillars.

Nothing can be said as to the form of the manubrium, all but the base having been destroyed.

The marginal zones have been torn off, as was also the case in Vanhöffen's and in the smaller of the *Albatross* specimens. And while the larger of the latter showed the distal terminations of the canals, and allowed a description of the rhopalia, the tentacles of this genus have yet to be seen.

The Bermudian specimens, like those previously seen, show the bathypelagic type of pigmentation, for they are given a reddish chocolate hue by pigment granules so large as to be individually visible under a magnification of only 3 diameters. Even the gelatinous substance is sparsely pigmented throughout; such of the subumbrella surface as is intact more densely so, likewise the surface of the sexual folds, though in places where the latter are torn, allowing the eggs to show through (specimen from Net No. 247), these are opaque white, as is also the case in *Aeginura*.

The depths of capture, listed above, added to preexisting records of 1,100-0 meters (Vanhöffen, 1902) and 549-0 meters (Bigelow, 1909), combined with the fact that a form so easily recognizable, and so striking in appearance has been taken on only 3 occasions, is sufficient proof that its habitat is exclusively bathypelagic.

AURELLIIDAE.

Aurellia.[29]

The written history of *Aurellia* extends back nearly two centuries, during which period many descriptions of its members have appeared, and discussion of their interrelationships. It has been the object of much investigation, embryologic, physiologic, and varietal; and it is commonly used as material for biological teaching. None the less, we still await critical revision of the seventeen "species" of *Aurellia* that have been named.

It is, however, generally accepted that most of these represent nothing more than contraction-phases, growth stages, individual variants, or at most environmental races of a much smaller number. Thus, Mayer (1910, p. 620, 622), in his tabular view of the genus, grouped all the named forms as either "*aurita* and its varieties" or "*labiata* and its varieties." Comparison, a few years later, between specimens of the *aurita* group from various Atlantic and Pacific localities, lead me to the conclusion that they are not separable into varieties, by any of the characters previously suggested (Bigelow, 1913, p. 98). And Stiasny (1919a; 1922, p. 524, 525), after a preliminary survey of the genus, concluded that all known Aurellias fall in one or another of four "wohlunterscheidbare grüppen, nicht Varietaten" of the "grossen Species *aurita*" characterized by differences in the number of canals arising from each genital sinus.

The difficulty in defining the forms of *Aurellia* (whatever be the taxonomic rank of these) lies in the fact that the character chiefly involved, in recent discussions, is one in which differences are gradual, not discontinuous, namely, the complexity of branching of the canals, and the extent to which the branches anastomose. The extremes in this respect are far apart. The one is represented by the simple state illustrated by Mayer (1910, p. 624, Fig. 397) for a Mediterranean example, in which the main perradial canals show no branching between the subdivision that takes place close to their points of origin, and the immediate vicinity of the bell margin, and in which anastomosis is also confined to the latter region. The other extreme is represented by the form first reported by Brandt (1838) from Kamchatka, and subsequently by Uchida (1934) and by me (1913; 1920) from northern Japan, from the Sea of Okhotsk, and from the Bering Sea-Alaska region, in which the perradials give off numerous branches throughout the outer ⅓ of their lengths, and in which there is any extensive anastomosis between all the primary systems, perradial, interradial, and adradial. I have already argued (Bigelow, 1913; 1920) that this form differs so sharply from typical *aurita* in this respect, (also in the dense pigmentation of the margin) as to deserve specific recognition as *A. limbata* Brandt. However, it proves that the further difference reported by Uchida (1934), namely wrinkled exumbral sense pits in *limbata*, smooth in *aurita*, is not a dependable specific character (unless perhaps for full-grown specimens), for while the pits in a large example from the Kurile Islands agreed with Uchida's description in their wrinkling (Bigelow, 1913, p. 100, Pl. 5, Fig. 2), they are smooth in the smaller specimens with *limbata* canalization that I have seen. Neither have I been able to demonstrate, on any of the Aurellias of this type, the partial closure of the mouth by flaps from the oral arms, reported by Uchida (1934) and thought by him to suggest rhizostome affinities. This perhaps represents a contraction phase.

Aurellia limbata, in short, is very closely allied to *aurita* though differing enough from the latter (at least in its typical form) for specific recognition. It also has a much more circumscribed range, for all records of Aurellias, the canals of which have shown the extreme complexity and exten-

[29] This name has usually been spelled *Aurelia*. But Peron and Lesueur's (1809) original spelling was *Aurellia*, as Mayer (1910, p. 619) points out.

sive anastomosis characteristic of *limbata* have (so far as I am aware) been from the Arctic or Subarctic; namely, from northern Japan, Kamchatka, Sea of Okhotsk, the Bering Sea region (Brandt, 1838; Uchida, 1934; Bigelow, 1913; 1920), and Greenland (Kramp, 1913, as "*A. flavidula*"). Thus it is circumpolar, as I have previously pointed out (Bigelow, 1920, p. 14).

The status of *A. maldivensis* Bigelow, and of *A. solida* Browne—the former recently redescribed by Stiasny (1935), the latter by Menon (1930) and by Rao (1931)—still remains uncertain.

Aurellia aurita Linné.

Medusa aurita, Linné, 1758, p. 660.

For early synonymy, see "*A. aurita*," Mayer, 1910, p. 623, 627, and "*A. labiata*," p. 628.

The more important subsequent discussions are listed above (p. 167).

Material: Net No. 296, 1,829-0 meters, July 12, 1929, 1 specimen, about 85 mm. in diameter.

Dip Net, Surface, October 16, 1930, 10 specimens, about 30-80 mm. in diameter.

Net No. 880, 914-0 meters, September 12, 1930, 1 specimen, fragmentary, about 85 mm. in diameter.

Also, 9 other Bermuda specimens, 25-90 mm. in diameter in the collection of the Museum of Comparative Zoology, collected in the summers of 1902, 1903, 1916, 1917.

The number of canal roots, arising from each genital sinus, shows the following range, in specimens of different sizes:

Diameter in mm.	Number of Specimens.	Number of Canals per Sinus.
25	2	3
30	1	3
33	1	3-4
35	1	3
37	1	3
40	2	3
45	1	3
50	1	3-4
52	1	3
55	1	1-3
75	2	3-5
80	2	3-5
90	1	4-5

Thus, most of the smaller examples would fall in the "*aurita*" group, according to Stiasny's (1922) subdivision, while the larger specimens bridge the gap between the latter and his "*colpota*" group. The first branching of the primary interradial canals is trichotomous, as Stiasny (1922) has emphasized, with further branching leading to the formation of what Mayer (1910, p. 624) has aptly named a "pitchfork-shaped system." In small Aurellias, the first branching of the interradial canals usually lies some distance distal to the boundary of each genital sinus. It is, in fact, probable that all Aurellias pass through this "*aurita*" stage in this respect, when

they are small. The outer boundaries of the sinuses spread centrifugally with growth. And it appears that the number of separate trunks that arise from a given sinus, in larger individuals, depends chiefly in how far outward the canal-system has become incorporated into the sinus, by the growth of the latter. With *Aurellia* proverbially variable and subject to abnormality, it is not astonishing that the number of canals often differs for the different sinuses of a given individual.

The Bermudian series gives evidence, in the foregoing tabulation, of the tendency toward an irregular increase in the number of canals, with growth, that is to be expected, on this basis. Failure of any of the specimens[30] to show a larger number of canal-roots than 5 per sinus is no doubt due to the fact that none of them was of large size. For example, the numbers per sinus in a large Cuban specimen, 250 mm. in diameter, are 6, 6, 8, 7.

I may note, in passing, that anastomosis of canals in the Bermudian specimens, is much as it has frequently been described for *A. aurita.*

General Distribution: It has long been known that *A. aurita* is one of the most abundant of medusae among the West Indies, and northward from Florida along the east coast of North America. It is also a familiar object at Bermuda, although no printed record of its presence seems to have appeared. Being strictly a neritic form, the specimens in the present collection were no doubt the product of the Bermuda Bank.

Faunistic Considerations.

Neritic and Holoplanktonic Communities.

It is safe to conclude—from the geographic location of the station where the towing was done—that all the medusae taken, of species that pass through a fixed stage in their development, were the products of Bermuda. Hence, a comparison of this neritic element, in the catches, with the holoplanktonic species gives a good indication of the extent to which a small isolated Bank may be expected to contribute to the medusan fauna of the open ocean nearby.

In the case of the Hydromedusae, out of a total of 717 specimens, the number belonging to species that are either known to pass through an attached hydroid stage, or may reasonably be assumed to do so,[31] does not exceed 17. This, I may point out, does not include the small series of *Bougainvillia niobe*, which has a budding phase, hence is placed in the holoplanktonic category, so far as its dispersal is concerned. That is to say, the contribution made by the neighboring slopes and shallows of Bermuda, to a point not ten miles distant, was less than 3% of the total catch. And the numerical paucity of the neritic element is the more striking, when one recalls that it represents at least 9 species, the holoplanktonic element (Tracho- and Narcomedusae) only 14. It is probable that if the station had been located but a few miles further offshore, the neritic element in the medusa fauna would have been negligible, as Thiel (1935) has shown it to be for the Central and South Atlantic as a whole.

In the case of the Scyphomedusae, the situation was the reverse, if judged from the standpoint of total numbers only, for the number of neritic specimens was raised considerably above that of the holoplanktonic by one catch of several hundreds of juveniles of *Linuche,* a genus which almost certainly passes through a scyphistoma stage, though not yet actually proven to do so. And a second large catch (66) was also made of *Carybdea xaymacana,* which also probably has a polyp stage in coastal waters. How-

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[30] Except for two abnormal tripartite specimens, each about 80 mm. in diameter, in which the number of canals per sinus were 9, 7, 9, and 9, 6, 7.
[31] *Zancleopsis, Pandea, Heterotiara, Calycopsis, Chromatonema, Aequorea, Olindias.*

ever, if the neritic and holoplanktonic groups of Scyphomedusae be judged, not by numbers of specimens, but by the frequency of occurrence, the latter group ranks far in advance, for 252 hauls yielded representatives of genera certainly or probably holoplanktonic (*Atolla, Periphylla, Pelagia*), while only 16 hauls and surface collections yielded genera which may be safely called neritic (*Carybdea, Tamoya, Nausithoe, Linuche, Aurellia*).   And apart from the two species just mentioned, neritic (or probably neritic) Scyphomedusae numbered only 23 specimens, holoplanktonic Scyphomedusae 549.

Apart, then, from sporadic contributions of 2 species, produced on the Bermuda Bank, the regular population was as characteristically holoplanktonic for the Scyphomedusae as for the Hydromedusae. Why it is that the young of *Linuche* and *Carybdea* drift offshore more frequently, or in greater numbers, than do other medusae produced on the Bermuda Bank, is a problem for the future.

VERTICAL DISTRIBUTION OF MEDUSAE AS A WHOLE.

If we omit the few specimens, for which depth data are not available; fragments which may not have represented individual medusae; and also the swarm of juvenile *Linuche*, mentioned above, the distribution of all the medusae combined with respect to depth of haul, was as follows:

Depth in Meters.	Number of Hauls Made.	Number of Medusae Taken.	Specimens per Haul.
0	86	126	1.5
183-0	10	0	0
366-0	12	0	0
549-0	23	10	0.43
732-0	40	18	0.45
914-0	132	189	1.44
1,097-0	134	246	1.83
1,280-0	132	245	1.85
1,463-0	132	235	1.79
1,646-0	135	234	1.73
1,829-0	135	220	1.63
2,012-0	4	21	5.25

The fact that the yields of 85 hauls at depths of 183-0 to 732-0 meters was so trifling, is good evidence that catches made in the deeper hauls can have owed very little, if anything, to what the nets picked up while being lowered and hauled up again. Consequently, the tabulation indicates that, numerically, the immediate surface, on the one hand, and a stratum from about the 900 meter level downward, were about equally populated, but that the intervening zone, some 700 meters thick, was practically barren. And omission of the neritic specimens from the surface catches, shows that this barren zone extended right up to the surface, for only 4 specimens of the holoplanktonic group were taken at the surface, namely, 1 *Liriope*, 1 *Halicreas*, and 2 *Aegina*.

Consideration of the comparative regularity of occurrence at different depths leads to a similar conclusion, as appears from the following tabulation:

Depth in Meters.	Number of Hauls Made.	Number with Medusae.	% with Medusae.
0	86	10 (3)	11 (.3)
183-0	10	0	0
366-0	12	0	0
546-0	23	4	17
732-0	40	12	30
914-0	132	55	41
1,097-0	134	67	50
1,280-0	132	66	50
1,463-0	132	64	49
1,646-0	135	71	52
1,829-0	135	61	45
2,012-0	4	4	100

By this criterion, for all medusae combined, and even including the swarms of juvenile *Linuche*, the medusae occurred less regularly at the surface than from about 600-0 meters downward, not at all in the intervening strata. And omission of the neritic forms lowers the surface frequency to a very small fraction of that of the deep layers, for only 3 out of the 86 surface hauls yielded holoplanktonic medusae (about 3%), or 1 for 28 hauls.

If the foregoing tabulations were taken at face value, they would suggest that medusae were about equally abundant and equally frequent from about 800 meters, or thereabouts, downward, with a decided maximum as deep as 2,000 meters. But consideration of the method by which the hauls were made shows that such a conclusion would almost certainly be incorrect, because the catches from the deepest hauls were no doubt augmented, both in frequency and in numerical yield, by what the nets picked up as they were lowered through the comparatively rich 500-800 meter stratum, and then hauled up through it again. The data are not of a sort to allow numerical calculation of the probable contamination resulting from this. But it may be safely assumed that with depth, below, say, 800 meters, this increased significantly and rapidly. And it is not unlikely that all the specimens yielded by the 4 hauls at 2,012-0 meters actually came from much smaller depths. In short, the data yields no positive evidence that there were any medusae as deep as this.

Reasoning then from the collections actually made at Dr. Beebe's station, it seems safe to conclude for the part of the Sargasso Sea represented by the Bermuda region:

1. That the neritic element among the Hydromedusae is numerically negligible; and that this also applies to the Scyphomedusae, except on occasions when swarms of one species or another may drift out for a few miles from the Bermuda Bank.

2. That the whole upper 500 meters of water is practically barren of medusae from spring, through summer, to autumn, except when such events take place. On these occasions, the immediate surface may be the most thickly populated zone. But it appears that these periods are of brief duration; nor is it likely that they affect the situation on a broad scale more than a few miles out from Bermuda.

3. That medusae as a whole in this part of the ocean basin are usually most abundant and occur most regularly at about 500-800 meters, below which they decrease, in both these respects, with increasing depth.

RELATIVE ABUNDANCE OF DIFFERENT SPECIES.

The relative abundance of the several species is shown in the following table:

Species.	Number.	Species.	Number.
Zancleopsis dichotoma	1	*Liriope tetraphylla*	1
Bougainvillia niobe	7	*Geryonia proboscidalis*	3
Pandea conica	1	*Cunina* sp?	1
Pandea rubra	4	*Solmissus incisa*	13
Heterotiara anonyma	2	*Aegina citrea*	31
Calycopsis sp?	2	*Aeginura grimaldii*	201
Chromatonema rubrum	2	? *Pegantha clara*	7
Aequorea floridana	2	*Carybdea xaymacana*	105
Olindias tenuis	3	*Carybdea alata*	3
Rhopalonema velatum	39	*Tamoya haplonema*	1
Pantachogon haeckeli	65	*Periphylla hyacinthina*	317
Colobonema typicum	47	*Nausithoe punctata*	6
? *Crossota brunnea*	50	*Atolla wyvillei*	232
Trachynemidae?	51	*Linuche unguiculata*	many
Halicreas minimum	186	*Pelagia noctiluca*	2
Halicreas glabrum	66	*Poralia rufescens*	3
Halitrephes valdivii	19	*Aurellia aurita*	12

ABSOLUTE ABUNDANCE.

Some estimate of the absolute abundance has proved interesting. Since the neritic forms may be regarded as sporadic invaders of the offshore waters, they may be left out of account in this connection. The number of holoplanktonic medusae of all kinds taken in the hauls from 549-0 meters and deeper, i.e., in the most productive zone, was about 1,406; the number of hauls 869; the number of hours of towing was 3,276; or an average yield of only 1.6 specimens per tow, or 0.42 specimen per hour's towing. Divided into groups, the catch was approximately 0.23 Trachomedusae and Narcomedusae combined, and 0.16 of the bathypelagic Scyphomedusae (*Atolla* and *Periphylla*) per towing hour.

QUANTITATIVE COMPARISON WITH OTHER REGIONS.

A quantitative comparison of the medusa population of the Bermuda region with that of the Mediterranean and of the Central and South Atlantic is interesting, as an indication of how the former—and its part of the Sargasso Sea as a whole—ranks as to productivity for this group, at different levels in the water, compared with other seas. Calculation of the Mediterranean catches made by the *Thor* as listed by Kramp (1924), but omitting one large catch of "many thousands" of *Liriope eurybia* in the Sea of Marmora (*Thor* Sta. 175, Kramp, 1924, p. 32), shows an average catch per hour's towing of about 41.5 medusae of all sorts, of about 36-37 Tracho-medusae and Narcomedusae combined, and about 2.5 Scyphomedusae. Since the *Thor* collections were made with a net with a mouth area of 3 square meters, towing at a rate of about 2 sea miles an hour, the Bermudian collection with one of only about 0.78 square meters, towed at a rate of 2-2½ knots, a factor of about 3.8 must be introduced to make the catches comparable. So adjusted, it is obvious that the Mediterranean was many times the more productive region, both for the holoplanktonic Hydromedusae, and for the medusae as a whole. In the case of the bathypelagic Schyphomed-usae, however—represented at Bermuda chiefly by *Atolla* and *Periphylla*,

but in the Mediterranean by the latter only—the two regions were about equally rich.

The Bermudian region is also poor in the holoplanktonic Hydromedusae, in general, as compared to the Central and South Atlantic as a whole, where the *Meteor* tows, with nets only half as large in diameter, yielded an average of about 5.4 specimens per 200 meters of towing at all depths and stations combined—a number that must be multiplied by a factor of perhaps 1.8 to correct for the size of the net alone, to be made comparable with the Bermuda average catch of only 0.23 per hour's towing. And the Atlantic figure would be much increased if the vertical *Meteor* tows were to be calculated on an hourly basis.

Reference to the foregoing discussion of vertical distribution (p. 170) makes it clear that this relative poverty of the Bermuda region results chiefly from the barrenness there of the upper 500 meters of water, in holoplanktonic medusae of any sort. In the Mediterranean, by contrast, most of the hauls from the upper 100 meters of water yielded considerable numbers of medusae, of one species or another (see Kramp's, 1924 lists), while most of the larger catches of the species most plentiful there, namely *Rhopalonema velatum* and *Liriope*, were from depths no greater than 300 meters. In the Central and South Atlantic also, the *Meteor* found Tracho- and Narcomedusae most abundant (10-11 individuals per 200 meters tow) between the surface and 200 meters, much less so in the deep underlying waters (Thiel, 1935, p. 43, Fig. 20, Table 3). And evidence in the same direction, in the Pacific, results from the rich catches of medusae of this category made in the Humboldt Current off northwestern South America, by the *Albatross* (Bigelow, 1909).

From the foregoing, it appears that the very warm superficial stratum of the Sargasso Sea is notably barren of medusae of the holoplanktonic category, but so far as the evidence goes, it suggests that the productivity of the deep waters in the more strictly bathypelagic types, represented by *Periphylla* and *Atolla*, is much more nearly of the same general order of magnitude there, as it is over the ocean basins as a whole[32], or in the Mediterranean.

It is interesting as illustrating the relative numerical abundance of two allied groups of pelagic coelenterates that the average Mediterranean catch of about 41 medusae per hour's towing mentioned above (p. 172), contrasts with a corresponding average of between 200 and 300 calycophorid siphonophores, both in the Mediterranean and in the neighboring parts of the Atlantic (Bigelow and Sears, 1937, p. 137). Evidently, the latter group is much the more numerous in that particular region. But it is doubtful how far regionally this generalization would apply, for the average *Meteor* catches per 200 meters of towing, of siphonophores and of Tracho- plus Narcomedusae, for the Central and South Atlantic did not differ greatly one from the other (cf. Leloup and Hentschel, 1935, p. 24, Fig. 17 with Thiel, 1935, p. 43, Fig. 20, Table 3).

In the Bermuda region, we have no direct comparison between the two groups, as there are no published records of siphonophores for the years 1929-1930, and as the numbers captured are not recorded for the one year on record (1931, Totton, 1936). We may, however, point out that they were only taken in 55 out of 374 hauls (usually only one species in a haul), or 14% of the tows in 1931, whereas the medusae were taken at 41% of all hauls in the summers of 1929-1930. Hence assuming that the several summers were comparable, it appears that medusae are actually more frequently encountered in the Bermuda region than siphonophores. And this area may thus prove to be as barren of the latter as the former.

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[32] Compare, for example, the catches of *Atolla* and *Periphylla* made in the North Atlantic by the *Michael Sars* (Broch, 1913).

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APPENDIX[1]

Species \ Net Number	13	16	17	18	21	22	23	24	25	26	29	31	32	33	34	35	36	39	41	42	43	44	45	48	49	50	51	52	53	56	58	60	62	64	65	66	67	68	69	73	74	75	76	78
Unidentifiable	1		2	1		2			2			2	1	1	1			1	1	1				2			1			2	1													
Aurellia aurita																																												
? Poralia rufescens																	1																											
Pelagia noctiluca																																												
Linuche unguiculata																																												
Atolla wyvillei								2	2	1			1	3	1									2						1			4				2							1
Nausithoe punctata																																												
Periphylla hyacinthina	1	3	2		1				5		2	3				1			1	1	1						1																	
Tamoya haplonema																																												
Carybdea alata																																												
Carybdea marsupialis xaymacana																																												
? Pegantha clara																		1																										
? Aeginura grimaldii								1								1																						1						3
Aeginura grimaldii		1	1	1									1			2			2	2		1	2		3					3	3	2	1	1										4
Aegina citrea																																												
? Solmissus incisa																																												
Cunina sp?																																												
Geryonia proboscidalis																																												
Liriope tetraphylla																		1																										
Halitrephes valdiviae																																												
Halicreas glabrum								2											1					1			1					2				1								
Halicreas minimum								1	1							1		1	3					1		1	1		2	1	1	2	1						1	2				
Trachynemidae genus?																																												
? Crossota																	1																2					1	1					
? Crossota brunnea																																												
Coloboneuma typicum								2						1																														
Pantachogon haeckeli											2			1										4			1																	
Rhopalonema velatum									5			1		2					4	1													1		2									
Olindias phosphorica tenuis																																												
Aequorea floridana																																												
Chromatonema rubrum																																												
Calycopsis sp?																																												
Heterotiara anonyma																																												
Pandea rubra																																												
Pandea conica																																												
Bougainvillia niobe																																												
Zanclopsis dichotoma																																												

Station numbers: 79, 81, 83, 88, 89, 94, 95, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 108, 110, 111, 114, 115, 116, 118, 119, 121, 122, 124, 135, 137, 138, 141, 142, 143, 144, 145, 153, 154, 157, 178, 196, 199, 203, 218, 220, 221, 234, 235, 240, 241, 242, 247, 253, 261, 262

¹ This table does not include a number (less than 10) of specimens for which no Net Number was available at the time of compiling table.

APPENDIX[1]

Net Number	Zanclopsis dichotoma	Bougainvillia niobe	Pandea conica	Pandea rubra	Heterotiara anonyma	Calycopsis sp?	Chromatonema rubrum	Aequorea floridana	Olindias phosphorica	Rhopalonema velatum	Pantachogon haeckeli	Colobonema typicum	? Crossota brunnea	? Crossota	Trachymedusae genus?	Halicreas minimum	Halicreas glabrum	Halitrephes valdiviae	Liriope tetraphylla	Geryonia proboscidalis	Cunina sp?	? Solmissus foltisa	Aeginia citrea	Aeginura grimaldii	? Aeginura grimaldii	? Pegantha clara	Carybdea marsupialis xaymacana	Carybdea alata	Tamoya haplonema	Periphylla hyacinthina	Nausithoe punctata	Atolla wyvillei	Linuche unguiculata	Pelagia noctiluca	? Poralia rufescens	Aurelia aurita	Unidentifiable
13																														1							1
16																														3							
17																														2							
18																								1													2
21																								1													1
22																														1		2					2
23																								1													
24																																					
25																1	2																				
26												2				1									1					5		2					
29																																1					2
31										5																											
32																														2							
33																														3							
34																																					
35										1			2											1													2
36										2			2	1																1		1					
39										2			1			1								2								3					
41											1														1							1					
42										4							1																				
43										1						1	3																				
44																1																					
45																																					
48																								2						2							1
49																								2		1				2							1
50																																				1	1
51																				1				1													
52											4													2						1		2					2
53																								2													1
56																1	1													1		2					
58																1	1																				
60											1													3								1					2
62																								1													1
64																2	1							3								4					
65																1	1							2													
66													1			2	2							1								2					
67										1			2											1													
68										2						1	2													1		1					
69																1														1							
73													1	1																							
74																1	2							3													
75																																					
76																																1					
78																								4													
79				1																																	2
81																																					1
83																1	1													1							
88											2						1													2							
89											1																			1							
90																																					
94											2																										
95								1			1																										
97								1																													1
98																																					
99								3			2																										
100																														7		2					
101								1			1				1																	2					
102														1																2		2					
103																																					
104																	2															1					1
105								1																													1
106																																					
108														3		1								2	2												1
110																														1		2					
111														1		1	1													3		1					
114																1																					
115																														1		1					
116														2										1	2					1							
118																	1																				
119																2														7							
121																		1						1						1							
122																														1		2					2
124																2	4													1							1
135																7	4	1									1			1		2					1
137																1														1		1					2
138															1															2						1	1
141																		1				1								1		1			1		
142																3	1	1																			
143																										1											
144																														1							

Net Number	263	267	268	269	270	271	273	274	279	280	291	292	293	294	295	296	297	343	357	359	360	362	368	371	383	400	401	405	406	427	434	442	447	448	449	451	455	459	466	468	481	484	488	501
Unidentifiable	1	1								1								1			1	1	1	1		1													2				1	1
Aurellia aurita															1																													
? Poralia rufescens																																												
Pelagia noctiluca																																												
Linuche unguiculata										1																																		
Atolla wyvillei									3	1		2	1								1												6											
Nausithoe punctata																																												
Periphylla hyacinthina	4		1	1		2	1	2	1	4	7	6						9	4											1		11					1							
Tamoya haplonema																																												
Carybdea alata																																						1		1				
Carybdea marsupialis xaymacana																																												
? Pegantha clara				1																																								
? Aeginura grimaldii												2							1															1										1
Aeginura grimaldii				1						1		1									2			1			1	3					1				3	1						
Aegina citrea	2								1		1		1																															2
? Solmissus incisa																																												
Cunina sp?																																												
Geryonia proboscidalis																																												
Liriope tetraphylla																																												
Halitrephes valdiviae																	1																					1						
Halicreas glabrum		1	5	3							2		3		1																		1			1			1				1	2
Halicreas minimum	2	4	17						6		3		2		1	1					1		1	3	1		2										2	3	3				1	1
Trachynemidae genus?	1										2																						1											
? Crossota												1																																
? Crossota brunnea																																												
Coloonema typicum									3	3		1	1								1							2																
Pantachogon haeckeli												4																																
Rhopalonema velatum																		1																										
Olindias phosphorica tenuis																																												
Aequorea floridana																																												
Chromatonema rubrum																	1																											
Calycopsis sp?																																												
Heterotiara anonyma																																												
Pandea rubra																																												
Pandea conica																																												
Bougainvillia niobe																																												
Zancleopsis dichotoma																																												

506 539 543 544 545 546 547 548 551 552 553 554 555 556 561 562 563 564 565 566 568 569 570 574 575 576 577 579 580 581 582 588 590 595 596 597 598 599 601 605 606 607 609 610 611 612 613 614 618 619 620 621 624 625 626

Net Number	Zanclopsis dichotoma	Bougainvillia niobe	Pandea cunica	Pandea rubra	Heterotiara anonyma	Calyptopsis sp?	Chromatonema rubrum	Aequorea floridata	Oliudias phosphorica	Rhopalonema tenuis	Rhopalonema velatum	Pantachogon haeckeli	Chthhnonema typicum	? Croseota brunnea	? Croseota	Trachynemidae genus?	Halicreas minimum	Halicreas glabrum	Haliteplose valdiviae	Liriope tetraphylla	Geryonia proboscidalis	Cunina sp?	? Solmissus incisa	Aegina citrea	Aeginura grimaldii	? Aeginura grimaldii	? Pegantha clara	Carybdea marsupialis xaymacana	Carybdea alata	Tamoya haplonema	Periphylla hyacinthina	Nausithoe punctata	Atolla wyvillei	Linuche unguiculata	Pelagia noctiluca	? Paralia rufescens	Aurellia aurita	Unidentifiable
263																								2							4							1
267																															1							1
268																															1							
269																1	2	1																				
270																	4	5							1		1				1							
271																	17	0													2							
273																															1							
274																															2							
279																															14							
280																															7							1
291																								1	1						6	3	1					
292													3				0							1	1													
293													3												1													
294																									1													
295													1	1		2	2	3							1	2					9	2	1					
296												4	1				2	3						1							4							1
297																	2	3																				
343													1				1		1																			1
357																		1	1																			1
359													1				1	1								1												1
360												1													2	1												1
362							1																			1								1				
368																																						
371													1																									
383													1				1								1													
400																	1								1													
401																	3																					
405																	1													1	1							
406																	1																					
427																									1													
434													2				2								3					11				6				
442																										1												
447																																						1
448																1													1									1
449													1				1													1	1							
451																		1					1		1													
455																																						2
459																												1										
460																	2	1							3	1												
468																	3									1												
481																	3																					
484																																						
488																								2	1													1
501													1				1	2							1													1

Net Number	Zanclopsis dichotoma	Bougainvillia niobe	Pandea cunica	Pandea rubra	Heterotiara anonyma	Calyptopsis sp?	Chromatonema rubrum	Aequorea floridata	Oliudias phosphorica	Rhopalonema tenuis	Rhopalonema velatum	Pantachogon haeckeli	Chthhnonema typicum	? Croseota brunnea	? Croseota	Trachynemidae genus?	Halicreas minimum	Halicreas glabrum	Haliteplose valdiviae	Liriope tetraphylla	Geryonia proboscidalis	Cunina sp?	? Solmissus incisa	Aegina citrea	Aeginura grimaldii	? Aeginura grimaldii	? Pegantha clara	Carybdea marsupialis xaymacana	Carybdea alata	Tamoya haplonema	Periphylla hyacinthina	Nausithoe punctata	Atolla wyvillei	Linuche unguiculata	Pelagia noctiluca	? Paralia rufescens	Aurellia aurita	Unidentifiable
506														2																								
539																	1	1							2									2				
543																																						
544																																	1	1				
545																																	1	1				
546																																	1	1				
547																																	1					
548																																	1					
551																																	1					1
552														5																	1							2
553																																		1				
554														2																				1				
555														1																								
556														1																			1	1				
561																																	1	3				
562		1		1																					1						1		1	1				3
563																				1											1		1	3				1
564																							1															
565													1										1								10							
566																	1								1						1							
568																																	1					
569																	2	1																				
570																																						
574																1															2			1				
575													1				1																					
576														1				1															1					
577													1										1															
579																				1													1					1
580														1																			1					
581																															1		1					
582														1									1								1							
588																															1			1				
590																				1											1			1				
595																															2			2				
596																															1			1				
597																										1							1	2				
598														3			4	1																2				
599																	4	1																1				
601																							1										1	1				
605														1											5						1			1				
607				1										1											1									1				1
609			1											1																								
610														1																	1			1				
011																																						
012																																		1				
013			1											1											3									1				1
614																						1																
618																				1													1					
619																															1							
620														1																	1			2				1
621																									5						1			2				1
624																						1																
625																															2			1				1
626													1	1			1	2													2			7				1

Net Number	627	628	631	632	633	634	635	637	638	639	640	641	642	643	644	645	646	647	648	649	652	653	654	657	658	659	663	665	666	674	676	680	681	682	683	684	685	686	687	688	690	691	692	693
Unidentifiable	1				1									3												1	1			1											2	1		
Aurellia aurita																																												
? Poralia rufescens																																												
Pelagia noctiluca																																												
Linuche unguiculata																																											2	
Atolla wyvillei	2	3	1			4	2							4	2			1			1		1				1	1	1		1	1				1			1	2				1
Nausithoe punctata	1																																											
Periphylla hyacinthina			1						1					1	3	1						1						1										1		1		1		2
Tamoya haplonema																																												
Carybdea alata																										1																		
Carybdea marsupialis xaymacana																																												
? Peganha clara																																												
? Aeginura grimaldii																																												
Aeginura grimaldii	3	4	1	3				1		1	2					2	2				3		2		2			6					6	3					2					
Aegina citrea	1																	1				1						1					1					1					1	1
? Solmissus incisa	1	1																															1											
Cunina sp?																																												
Geryonia proboscidalis																																												
Liriope tetraphylla																																												
Halitrephes valdiviae				1																																								
Halicreas glabrum																																												
Halicreas minimum						1											1					1												3	1	1								
Trachynemidae genus?														4																			1											
? Crossota								1									1			1										3														
? Crossota brunnea									2																					1														
Colobonema typicum						1			1										1															1										
Pantachogon haeckeli	1																		1					2	1	2		2							1	2								1
Rhopalonema velatum					1	2					2																							1										
Olindias phosphorica tenuis																																												
Aequorea floridana																																												
Chromatonema rubrum																																												
Calycopsis sp?																																												
Heterotiara anonyma																																												
Pandea rubra																																												
Pandea conica																		1																										
Bougainvillia niobe																																												
Zancleopsis dichotoma																																												

694 695 698 699 700 701 702 703 707 708 709 710 712 713 714 715 716 717 718 719 720 721 722 723 724 725 726 727 728 730 731 732 733 734 735 736 738 739 740 741 742 745 746 748 750 751 752 753 756 757 758 759 760 761 762